Syllabus of Mathematics courses for Integrated MSc
[All courses carry 4 credits each]

BRIDGE COURSE-MATHEMATICS (MM 102)

I. ALGEBRA

Binomial theorem, General term, Middle term, problems based on these concepts Permutations and combinations Sequences and series (Progressions.)

Matrices.(2x2 and 3x3 matrices); Determinant and Inverse of a Matrix, system of linear equations and their solution, Eigen values.

Mathematical Induction.

II. CO ORDINATE GEOMETRY (Two Dimensional Geometry)

1. Co ordinate system: Distance formula, section formula, area of Triangle…etc.,
2. Straight Lines, angle between two lines, concurrent lines ,distance between two lines.
3. Conic Section.

III. TRIGONOMETRY

1. Introduction to Trigonometric ratios, [proof of sin(A+B), cos(A±B), tan(A±B)… formulae]
2. Multiple and sub multiple angles, sin2A, cos2A,tan 2A ….etc..,
3. Transformations. Sum into product and product in to sum formulae, problems.
4. Sine rule and Cosine Rule

IV. CALCULUS

1. Limits. Standard formulae, and problems
2. Differentiation: First principle, UV rule, U/V rule, Methods of Differentiation.
3. Applications of Derivatives
4. Integration, methods of integration, product rule, Substitution method.

References

1. NCERT class IX and XII text books.
2. Any state board mathematics test books of class XI and XII

2. Math-1 Linear Algebra and Complex Variable (MM103)

1.1 Matrices (20 Lectures)

Basic concepts of matrices, multiplication of matrices by scalars, addition and multiplication of matrices, transpose, trace, determinant of a matrix, rank and inverse of a matrix, special matrices such as Hermitian, unitary matrices, system of linear equations, solution by Crammer's rule, existence and general properties of solutions, eigenvalues, eigenvectors, diagonalization of matrices, functions of matrices and Caley-Hamilton theorem.

1.2 Elementary functions (7 lectures)

Definition and examples of sequences and series. Using these, study Trigonometric functions, logarithmic, exponential function, hyperbolic trigonometric functions.

1.3 Analytical geometry in 3-D (8 Lectures)

Cartesian co-ordinates in 3-D, distance between two points, direction cosines, direction ratios and their properties, equation of plane using given data, distance between a point and a plane, equation of straight line in different forms, image of a point with respect to a plane, distance between a point and a plane along a straight line, equation of sphere, circle.

1.4 Complex numbers, vector algebra (5 Lectures)

Algebra of complex numbers, polar form, argand diagram, triangle inequality, curves and regions in complex plane.

Addition of vectors, dot product, cross product and their geometric interpretation, triple product, area, volume given in terms of vector products.

References

1. Linear algebra, Kenneth Hoffman and Ray Kunze,Pearson, 1971.
2. Linear algebra: a geometric approach, S. Kumaresan, Prentice hall of India, 2004.
3. Calculus and analytic geometry, George Thomas & Ross Finney, Addition Wesley, 1995.

2. Math-2 Multi Variable Calculus (MM152)

2.1 Multivariable calculus (25 Lectures)

Brief introduction to co-ordinate systems- spherical and cylindrical systems double integral over a rectangle, double integral over a region, change of order of integration, triple integrals, change of variables and Jacobian.

Vector fields, gradient, divergence, curl, vector calculus identities, parametric curves, line integrals, path dependence, fundamental theorems of line integrals, conservative fields, application of Greens theorem in 2-D, parametric surfaces, surface of revolution, surface integrals, applications of Stokes theorem and Gauss divergence theorem, Green's identities, statement of integration by parts.

2.2 Mathematical Analysis (15 lectures)

Rational numbers, sequences, subsequences, monotonicity, boundedness, convergence, limit of a sequence, Cauchy criteria, series, different tests of convergence, power series, radius of convergence.

References

1. Calculus, Vol. 2: Multi-Variable Calculus and Linear Algebra with Applications to Differential Equations and Probability, Tom M. Apostol, Wiley and Sons, 1969.
2. Higher engineering Maths, B.S.Grewal, Khanna Publishers, 2001.
3. Calculus and analytic geometry, George Thomas and Ross Finney, Addition Wesley, 1995.
4. R.G.Bartle and D.R.Sherbert,Introduction to Real Analysis, Wiley and Sons, 2011.
5. Richard R. Goldberg, Methods of Real Analysis, Wiley and Sons, 1976.

3. Math-3(A) Ordinary Differential Equations (MM202)

3.1 Ordinary Differential Equations (17 Lectures)

Order and degree of a differential equation, first order equations: variables separable method, homogeneous equations of degree zero, non-homogeneous equations, exact equations, integrating factor, linear equations, Bernoulli's equation. Higher order homogeneous linear equations with constant coefficients, second order homogeneous linear equation with variable coefficients, variation of parameters, 2 x 2 autonomous system of equations, power series solution, meaning of existence and uniqueness of a solution and some counter examples.

3.2 Laplace Transforms (15 Lectures)

Definition, L.T. of some elementary function, effect of L.T. on translation, scaling, convolution. Inverse Laplace transform, applications of L.T. to ODE.

3.3 Fourier series (5 Lectures)

Fourier series of a periodic function, half range Fourier series.

3.4 Sets, relations and functions (3 Lectures)

Sets, relations, equivalence, partial ordered relations, mathematical induction, elements of mathematical logic.

<u>References</u>

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley and Sons, 2011.
2. Differential equations with applications and historical notes, George F. Simmons, McGraw Hill Inc, 1972.
3. Elementary Differential Equations, William E. Boyce (Author), Richard C. DiPrima, Wiley and Sons,2012.

4. <u>Math-3(B)</u> <u>Introductory Probability and Statistics</u> (MM203)

Random Experiments Sample spaces , Events, probability measures on events definition, properties, examples. Conditional probability-definition, properties, examples, Bayes theorem, independent events.

Definition of random variables, standard discrete and continuous random variables-viz. Bernoulli, Binomial, Geometric, Poisson, Exponential, Gamma, Normal. Expectation, variance, other properties.

Definition of bivariate random variables, joint distributions, covariance and correlation between two random variables, independence, distributions of sums.

Data collection methods, types of data, graphical summaries of data, numerical summaries of univariate data, bivariate summaries, measures of association.

Introduction to statistical inference, population parameters, variable(s) of interest, statistic, estimators as random variables.

References

1. Ross, S. A First Course in Probability, sixth edition, Pearson Education, 2007.
2. Ramachandran, K.M. and Tsokos, C.P. Mathematical Statistics with applications, Academic Press, 2009.
3. Daniels, W.W. Biostatistics: a foundation for analysis in the health sciences, 9th edition, John Wiley & Sons, 2008.
4. Moore, D.S. The Basic Practice of Statistics, W. H. Freeman, 2003.

5. Math-4(A) Analysis (MM253)

5.1 Continuity (15 Lectures)

Continuity (stick to sequential and ϵ, δ definition), examples of continuous functions, some basic properties of continuous functions including intermediate value theorem.

5.2 Differentiation (15 Lectures)

Limit of a function, Differentiation, chain rule, mean value theorems and their applications, Taylor's theorem, l'Hospital rule, maxima-minima problems in one variable case, curve tracing.

5.3 Integration (10 Lectures)

Integration, Riemann's original definition and applications to summation of infinite series, Statement of fundamental theorem of calculus.

References

1. R.G.Bartle and D.R.Sherbert,Introduction to Real Analysis, Wiley and Sons, 2011.
2. Richard R. Goldberg, Methods of Real Analysis, Wiley and Sons, 1976.
3. Tom M.Apostol, Mathematical Analysis, Pearson, 1974.
4. Ajit Kumar and S. Kumaresan A Basic course in Real Analysis, Chapman and Hall, 2014.

6. Math-4(B) Algebra (MM254)

6.1 Group theory (20 Lectures)

Groups, examples, subgroups, order of an element in a group, cyclic groups, cosets, normal subgroups, permutation groups, quotient groups, Lagrange's theorem. Group homomorphisms, isomorphisms, fundamental theorem of group homomorphism and applications.

6.2 Vector spaces, Linear transformations (15 Lectures)

Vector space, examples, subspace, spanning set, linear dependence, linear independence, basis, dimension, sum of two subspaces, linear transformations, isomorphism, co-ordinates, _nite dimensional vector spaces are isomorphic to Rn, rank-nullity theorem, dimension of quotient spaces, matrix of a linear transformation (stick to 2 x 2 or 3 x 3 case).

6.3 Rings, integral domains and fields (5 Lectures)

Definitions and examples of rings, commutative rings, subrings, ideals, integral domains and fields with various examples.

References

1. Contemporary abstract algebra, Joseph Gallian, Cengage 2012.
2. Topics in algebra, I.N. Herstein, Wiley and Sons, 1975.
3. Linear algebra, Kenneth Ho_man and Ray Kunze,Pearson, 1971.
4. Linear algebra: a geometric approach, S. Kumaresan, Prentice hall of India, 2004.

Semester 4

Mathematical Methods for Physics (in place of Math 4B)

Topics	**No. of lectures (44)**
Overview of Elementary Calculus	4
Matrices, Vector spaces, Basis, Eigenvalues and Eigenvectors, Schur's Lemma, Cayley Hamilton theorem, Matrix Diagonalization	10
Sturm Liouville Theory: Orthogonal Functions, Self Adjoint ODE's Gram Schmidt Orthogonalization. Completeness of Eigen functions, Rodrigues formula, Special functions (introduction)	10
Introduction to Tensors: Covariant, contra- variant tensors, tensor calculus, symmetric and Anti-symmetric tensors. Applications of tensors to physical problems	10
Elementary concepts in group theory and group representations. Discrete groups. Symmetric groups. Matrix Representations. Character tables. Reducible and irreducible representations. Introduction to Rotation Groups. Physical applications.	10

Books recommended:

1. Main Text. *Mathematical methods for Physicists* , Arfken, George B and Weber Hans J and Harris (Academic Press) 7 edition (2000)
2. *Group Theory and Its Physical Applications*, Falicov, L.M (University of Chicago Press)
3. *Tensor Analysis for Physicists* J.A. Schouten (Dover)
4. *Classical theory of fields by* Landau and Lifschitz.
5. *Schaum Outline Series* , "Calculus", "Linear Algebra" and "Group Theory" (to be used as supplementary material, not as textbooks)
6. *A brief on Tensor analysis By* James D. Simmonds (Springer 1994)