CURRICULUM B.Tech.

PROPOSED SYLLABUS

May 2017

List of proposed B. Tech. courses (Curriculum workshop, 8-9 May 2017)

S.No.	Course Code	L	T	P	C
1.	**MAT 101 Mathematics-I**	3	1	-	4
2.	**MAT-102 Mathematics-II**	3	1	-	4
3.	**MAT 103 Mathematics-I (B. Arch.)**	3	1	-	4
4.	**MAT-402 Complex Analysis**	3	-	-	3
5.	**MAT-403 Abstract Algebra**	3	-	-	3
6.	**MAT-404 Numerical Methods**	3	-	-	3
7.	**MAT-405 Probability and Statistics**	3	-	-	3
8.	**MAT-406 Operation Research**	3	-	-	3
9.	**MAT-407 Information Theory and Coding**	3	-	-	3
10.	**MAT-408 Linear Algebra**	3	-	-	3
11.	**MAT-409 Integral and Discrete Transforms**	3	-	-	3
12.	**MAT-410 Discrete Mathematical Structures**	3	-	-	3
13.	**MAT-411 Graph theory**	3	-	-	3
14.	**MAT-412 Advanced Differential Equations**	3	-	-	3
15.	**MAT-413 Number Theory**	3	-	-	3
16.	**MAT-414 Measure Integral and Probability**	3	-	-	3
17.	**MAT-415 Random Variables & Stochastic Process**	3	-	-	3

MAT 101 Mathematics-I 3L+1T 4 Credit

Matrices: Linearly dependent and independent vectors**,** Rank, consistency of a linear system of equations and their solutions, Eigen values and Eigen vectors, Cayley-Hamilton theorem (statement only) & its applications, diagonalization of matrices, application to classification of conics.

Differential Calculus : Concavity, convexity and points of inflexion, asymptotes, curve tracing (Cartesian, parametric and five polar curves-Folium of Descartes, Limacon, Cardioids, Lemniscates of Bernoulli and Equiangular spiral and other simple polar curves).

Partial differentiation, Euler's theorem on homogeneous functions, total differentiation, approximate calculation,

Integral Calculus: Improper Integrals (Beta and Gamma functions and their properties), area and length of curves. Surface area and volume of solid of revolution, Double integrals, change of order of integration. Triple integrals, Change of Variables (Cartesian, polar, cylindrical and spherical coordinates).

Vector Calculus: Differentiation and integration of vector-valued functions of scalar variables, scalar and vector fields, gradient, directional derivative, divergence, curl. Line, surface and volume integrals. Green's, Gauss's and Stokes's theorems (statement only) and their simple applications.

Text and reference books:

1. Zill D. G. and Wright W. S., *Advanced Engineering Mathematics*, 9th Ed., Jones & Bartlett India Private Limited, 2011.
2. Ramana B.V., *Higher Engineering Mathematics*, McGraw – Hill, New Delhi, 2007.
3. Thomas G. B. and Finney R. L., *Calculus and Analytic Geometry*, Addison-Wesley, 1988.
4. O'Neil P. V., *Advanced Engineering Mathematics*, Cengage Learning, New Delhi, 2016.
5. Jain R.K. and Iyengar S. R. K., *Advanced Engineering Mathematics*, Narosa publications, New Delhi, 2002.
6. D. W. Jordan & P. Smith, *Mathematical Techniques*, Oxford publications, 2008.
7. Narayan Shanti, *A Text book of Matrices*, S.Chand and Co., 1957.
8. Narayan Shanti, *Differential Calculus*, S.Chand and Co., 2005.
9. Narayan Shanti, *Integral Calculus*, S.Chand and Co., 2005.
10. Kumaresan S., *Linear Algebra: A Geometric Approach*, PHI Learning, 2000.

MAT-102 Mathematics-II 3L+1T Credits: 4

Differential equations of first order and first degree:- linear form, reducible to linear form, exact form, reducible to exact form, Change of Variables.

Higher order linear differential equations with constant coefficients: Complimentary function and particular integrals.

Second order ordinary differential equations with variables coefficients: Change of Independent Variable (Homogeneous, General form), Exact form, reducible to exact form, change of dependent variable (One part of complimentary function is known, Normal form), method of variation of parameters.

Series Solution: Real Sequences and series, their convergence, power series, radius of convergence**,** recurrence relations, solution in series of second order LDE with variable coefficient (C.F. only). Regular singular points and extended power series (Frobenius Method).

Partial Differential Equations: Formulation and classification of linear and quasi- linear partial differential equation of the first order (Lagrange's method). Non-linear partial differential equation of first order, Four Standard forms, Charpit's Method .

Fourier series: Fourier series, full range and half range series, change of intervals.

Text and reference books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley.
2. George F. Simmons & S.G. Krantz, Differential Equation, Tata McGraw – Hill.
3. B.V. Ramana, Higher Engineering Mathematics, McGraw – Hill.
4. Peter V. O'Neil, *Advanced Engineering Mathematics*, Cengage Learning, New Delhi.
5. M Ray, *A Text Book On Differential Equations*, Students Friends & Co., Agra-2.
6. Robert C. Mcowen, *Partial Differential Equation*, Pearson Education.
7. R.K. Jain & S R K Iyengar, *Advanced Engineering Mathematics*, Narosa, New Delhi.
8. T. Amaranath , *An Elementary Course in Partial Differential Equations*, Narosa, New Delhi.
9. S.G. Deo and V. Raghavendra, *Ordinary Differential Equations*, Tata McGraw Hill Pub. Co., New Delhi.

MAT 103 (B. Arch.) Mathematics-I 3L+1T Credits: 4

Differential Calculus: (Cartesian form) Asymptotes, curvature, concavity, convexity and points of inflexion, curve tracing, partial differentiation, Euler's theorem on homogeneous functions.

Integral Calculus: (Cartesian form) Area and length of curves, surface area and volume of solid of revolution, double integrals, change of order of integration.

Matrix: Rank and inverse of a matrix by elementary transformations, consistency of linear system of equations and their solutions, Eigen values, Eigen vectors, Cayley- Hamilton theorem (statement only) & its applications.

Coordinate Geometry of Three Dimensions: Equation of a sphere, plane section of a sphere, tangent plane, orthogonality of spheres, definition and equation of right circular cone and right circular cylinder.

Text and reference books:

1. R.K.Jain and S R K Iyengar, Advanced Engineering Mathematics, Narosa.
2. Thomas & Finney Calculus and Analytic Geometry, Addison-Wesley Pub. Co.
3. B.V.Ramana, Higher Engineering Mathematics, McGraw – Hill.
4. Shanti Narayan, A Text book of Matrices, S.Chand and Co.
5. Shanti Narayan, Differential Calculus, S.Chand and Co.
6. Shanti Narayan, Integral Calculus, S.Chand and Co.

MAT-402 Complex Analysis 3L 3 Credits

Analytic Functions: Functions of complex variable, limits and continuity, differentiability, Cauchy – Riemann equations, analytic function, harmonic functions, Milne-Thompson method, conjugate functions.

Conformal Mapping: Mappings or transformations, conformal mapping, necessary and sufficient conditions for $w = f(z)$ to represent conformal mapping, linear, bilinear and some important transformations, cross ratio, Schwarz – Christoffel transformations.

Complex Integration: Line integral, Cauchy fundamental theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy derivative formula, Morera's theorem, Liouville's theorem

Expansion of analytic function: Expansion of analytic function as power series (Taylor series) zeros and poles, isolated and essential singularities, meromorphic functions, Laurent series.

Calculus of Residues: Residue at simple pole, residue at a pole of order greater than unity, the Cauchy's residue theorem, evaluation of real definite integrals.

Text and reference books:

1. R. V. Churchill, J. S. Brown, Complex Variables & Applications –Tata McGraw Hill Eduction, 2009.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley.
3. S. Ponnusamy, Foundation of Complex Analysis, Narosa Publications.
4. J.H. Mathews and R.W. Howell, Complex Analysis for Mathematics and Engineering, Narosa Publications.
5. L. Ahlfors, Complex Analysis, McGraw Hill.
6. T. W. Gamelin, Complex Analysis, Springer.

MAT-403 Abstract Algebra 3L 3 Credits

Group theory : Groups, semi groups and monoids, subgroups and cosets, Lagrange's theorem, normal subgroups, homomorphisms and factor groups. Structure of cyclic groups, permutation groups, dihedral groups, Sylow's theorems (statement only). Structure of finite abelian groups (statement only) and examples.

Rings: Rings, subrings, homomorphisms of rings, divisibility in rings, ideal and quotient rings, integral domains, primal and maximal ideals, examples of rings including polynomial rings and rings of matrices.

Field theory: Fields, subfields, field extensions, degree of a field extension, applications of field theory to construction by ruler and compass.

Text and reference books:

1. Michael Artin, Algebra, Pearson Education.
2. John Fraleigh, First Course in Abstract Algebra, Pearson Education.
3. John A. Beachy and William D. Blair, Abstract Algebra, Second Edition, Waveland Press.
4. John A. Beachy, Abstract Algebra II, Cambridge University Press, London Mathematical Society Student Texts #47, 1999.
5. J. Gallian, Contemporary Abstract Algebra, 8th Edition, 2013.
6. I. N. Herstein, Topics in Algebra, 2nd Edition, John-Wiley, Cengage Pub. 1975
7. R.K. Sharma ,S.K. Shah and G. Shankar, Algebra I, Pearson.

MAT -404 Numerical Methods 3L 3 Credits

Error analysis: Representation of numbers in computers and their accuracy, **f**loating point arithmetic, concept of zero, errors in computations, types of errors, propagation of errors, computational methods for error estimation, general error formulae, approximations of functions and series.

Roots of algebraic and transcendental equations: Bisection method, Regula-falsi method, successive iteration method, Newton-Raphson method.

Solution of simultaneous algebraic equations: Gauss elimination method, Gauss Jordan method, decomposition method, Jacobi and Gauss-Seidel iteration methods.

Interpolation and finite differences: Forward, backward and central differences, relations between the operators, Newton's forward and backward differences interpolation formulae, Stirling, Bessel and Gauss formulae for central difference, numerical differentiation, Lagrange, Hermite and Newton's divided difference interpolation formulae for unequal interval,.

Numerical Integration: Gaussian-Legendre quadrature formula, Trapezoidal, Simpson's one-third, Simpson's three-eighth quadrature formula, Weddle's rule .

Ordinary Differential Equations: Taylor's series method, Picard's method, Euler's and modified Euler's methods, Runge-Kutta fourth order method, Milne's Predictor-Corrector method.

Text and reference books:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Limited.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India.
3. J N Sharma, Numerical methods for Engineers and Scientists, 2nd edition, Narosa Publishing House, New Delhi.
4. G.D. Smith, Numerical Solutions to Partial Differential Equations, Brunel Univ. Clarendon Press.
5. V.N. Vedamurthy and N.Ch.S.N. Iyengar, Numerical Methods,Vikas Publishers.
6. B.S.Grewal, Numerical Methods in Engineering and Science, Khanna Publishers.

MAT-405 Probability and Statistics 3L 3 Credits

Probability theory Axiomatic definition, properties of probability, conditional probability, independence, Baye's theorem.

Discrete Distributions: Probability distribution functions and cumulative distribution functions, Mean and variance, moment-generating functions, marginal and conditional probability distributions, binomial and Poisson distribution.

Continuous Distributions: Probability density functions and cumulative distribution functions, mean and variance, moment generating functions, marginal and conditional probability distributions, some specific continuous distributions, normal and exponential distributions.

Functions of Random Variables: Distribution function technique, transformation technique, moment-generating function technique.

Sampling Distributions: χ-Square test, t- test and F- test, I.I.D. (Identically and Independently Distributed) random variable, law of large numbers, Central limit theorem, estimation of parameter and testing of hypothesis.

Text and reference books:

1. Hogg, R.V. & Craig, A.T., Introduction to Mathematical Statistics, 5th Ed., Prentice-Hall, Inc., Englewood Cliffs, N.J., 1995.
2. Mood, A.M., Graybill, F.A. and Boes, D.C., Introduction to the Theory of Statistics, 3rd Ed. McGraw Hill, Inc., New York, 1974.
3. DeGroot, Morris H., and Mark J. Schervish. Probability and Statistics. 3rd ed. Boston, MA: Addison-Wesley, 2002. ISBN: 0201524880.
4. Freund, W.J., Mathematical Statistics, 5th Ed., Prentice-Hall, Inc., Englewood Cliffs, N.J., 1994.
5. Hoel, P.G., Mathematical Statistics, 5th Ed., John Wiley & Sons, Inc., NewYork, 1984.
6. Billingsley P., Probability and measure, Wiley publications.

MAT-406 Operation Research 3L 3 Credits

Introduction of Operations Research: History, nature and significance of operations research (OR), models and modeling in OR, Applications and scope of OR, general methods of solving the problems in OR.

Linear programming: Introduction, general structure of linear programming (LP) models, methods of solving: graphical method, simplex method. Duality in LP, Assignment problem, Game theory. Transportation Problem**:** Mathematical statement of transportation problem, methods of finding basic feasible solution (BFS), test of optimality, MODI'S method for optimal solution, variation in transportation problem.

Quadratic programming: Wolfe's and Beale's method.

Network Analysis: Project planning and control with PERT-CPM

Text and reference books:

1. S.D. Sharma, Operations Research, Kedarnath Publications.
2. S.S. Rao, Engineering Optimization Theory & Practice, Wiley and Sons, USA.
3. J.K. Sharma, Operations Research Problems and Solutions.
4. Winston, Operations Research.
5. H.A. Taha, Operations Research.
6. P.K. Gupta & D.S. Hira, Operations Research.
7. Kantiswaroop, Operations research

MAT-407 Information Theory and Coding 3L 3 credits

Mathematical foundation of information theory in communication system: Measures of information- self information, Shannon's entropy, joint and conditional entropies, mutual information and their properties.

Discrete memory less channels: classification of channels, calculation of channel capacity. Source coding, and channels coding. Unique decipherable codes, condition of instantaneous codes, average codeword length, Kraft inequality. Shannon's noiseless coding theorem. Construction of codes: Shannon fano, Shannon binary and Huffman codes. Higher extension codes. Decoding scheme- the ideal observer decision scheme.

Error correcting codes: minimum distance principle. Relation between distance and error correcting properties of codes, the Hamming bound. Construction of linear block codes, parity check coding and syndrome decoding.

Text and reference books:

1. Gallager, R. G., *Information theory and Reliable Communication,* John Wiley & Sons,Inc., New York, 1968.

2. Robert Ash, *Information Theory, Dover Publication,* New York, 1965.

3. Reza, F. M., *An Introduction to Information Theory,* McGraw Hill, New York, 1961.

4. Peterson, W. W. and Weldon, E. J., *Error correcting codes,* MIT, 1961.

5. Mceliece, S. J., *The theory of Information and Coding*; Student Edition (Encyclopedia of Mathematics and its Applications), Cambridge University Press, 1977.

MAT-408 Linear Algebra 3L 3 Credits

Fields and linear equations.vector spaces, sub spaces, linear combinations, spanning sets, dimension and basis, linear transformations. Rank and nullity of linear transformation. Representation of transformations by matrices. Duality and transpose of a linear transformation. Linear functional, dual space.

Eigen values and eigen vectors, characteristics polynomials, minimal polynomials. Cayley Hamilton's theorem, triangularization, diagonalization. Inner product spaces. Orthogonality, Gram – Schmidt orthonormalization. Orthogonal projections. Linear functionals and adjoints. Unitary and normal operators. Spectral theorem for normal operators.

Bilinear forms, symmetric and skew symmetric bilinear forms, matrix of a bilinear form.

Text and reference books:

1. K. Hoffman and R. Kunze, Linear Algebra, PHI Learning, 2009.
2. S. Lang, Linear Algebra, Springer India, 2005.
3. M. Artin, Linear Algebra, Pearson education.
4. I. N. Herstein, Linear Algebra, Wiley India Pvt. Ltd., 2006.

MAT-409 Integral and Discrete Transforms 3L 3 Credits

Laplace Transforms: Laplace Transforms of elementary functions, inverse Laplace transformations, Heavisides' unit step function, Dirac delta function, first and second shifting theorems, transforms of derivatives and integrals, convolution theorem, solution of ordinary differential equation with constant coefficients and partial differential equations with special reference to heat equation, wave equation, Laplace and Poisson equation.

Fourier Transforms: Fourier integral formula, exponential Fourier transform, inverse Fourier transform, Fourier sine and cosine transforms, applications to integral equations.

Solution of second order PDE: Method of separation of variables, wave equation, diffusion equation and Laplace equation in two dimensions, Poisson equation (Cartesian coordinates).

Z- Transforms: Linearity, Z -Transform of elementary functions, shifting theorems, initial and final value theorems, Convolution theorem, inversion of Z-Transform, solution of difference equations using Z- Transform.

Mellin Transforms: Definition and properties of Mellin transform, shifting and scaling properties, Mellin transforms of derivatives and integrals, Applications of Mellin transform.

Hankel Transforms: Basic properties of Hankel transform, Hankel transform of derivatives, Application of Hankel Transform to PDEs.

Text and reference books:

1. H.K.Dass, Advanced Engineering Mathematics, S.Chand and Co.
2. Andrews Larry C. and Shivamoggi Bhimsen K., Integral Transforms for Engineers, Prentice Hall of India, 2003.
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley.
4. R.K.Jain and S R K Iyengar, Advanced Engineering Mathematics, Narosa .
5. B.V.Ramana, Higher Engineering Mathematics, McGraw – Hill.
6. T. Amarnath, Partial Differential Equation and its application, Narosa .
7. Sankara Rao, Introduction to Partial Differential Equations, Prentice Hall of India.

MAT-410 Discrete Mathematical Structures 3L 3 Credits

Logic: Propositional Logic, language of propositional logic, truth table, natural deduction, predicate logic: language of predicate logic, Logical inference with Quantifiers. Proof techniques: Introduction to different standard proof techniques.

Set Theory: Review of basic set operations, cardinality of a set. Relations, Types of relations, operations of relations and applications, Poset, Congruence arithmetic.

Combinatorics: Counting techniques: Pigeon Hole principle, inclusion exclusion principle, recurrence relation and generating function.

Graph Theory: Graph as a discrete structure, Modeling applications using graphs, Hamiltonian graphs, Planar graphs, Graph coloring, Matching.

Text and reference books:

1. C. L. Liu and Mohapatra, *Elements of Discrete Mathematical*, 4th Edition, Tata McGraw Hill Edu., 2012.
2. K. H. Rosen, *Discrete Mathematics and Its Applications with Combinatorics and Graph Theory*, 7th Edition, Tata McGraw Hill Edu. 2012.
3. D. B. West, *Introduction to Graph Theory*, Second Edition, Pearson, 2001.

MAT-411 Graph theory 3L 3 Credits

Definition and basic concepts, Trees, characterizations, counting of minimum spanning tree, graph and matrices, Paths and distance in graphs, center and median of a graph, activity digraph and critical path, Eulerian graphs, Definition and characterization,

Hamiltonian graphs, Necessary and sufficient conditions, Planar Graphs: properties, dual, genus of a graph. Peterson graph.

Graph coloring, vertex coloring, chromatic polynomials, edge coloring, planar graph coloring, Matching and factorizations, maximum matching in bipartite graphs, maximum matching in general graphs, Hall's marriage theorem, factorization, Networks, The Max-flow min-cut theorem, connectivity and edge connectivity, Menger's theorem.

Text and reference books:

1. D. B. West, *Introduction to Graph Theory*, Second Edition, Pearson, 2001.
2. R. J. Wilson, *Introduction to Graph Theory*, Fourth Edition, Prentice Hall, 1996.
3. J. A. Bondy and U. S. R. Murty, *Graph Theory,* Springer, 2008.

MAT-412 Advance Differential Equations 3L 3-Credits

Ordinary differential equations: System of simultaneous linear differential equations with constant and variable coefficients, Total (pfaffian) equation.

Partial differential equations: Monge's method, Solutions of linear PDE with constant coefficients using differential operators, Reducible and irreducible non-homogeneous linear PDE, Homogeneous linear PDE with constant coefficients. Classification of second order PDE and reduction to canonical forms, Laplace, wave and diffusion equations in various coordinate systems and their solutions under different initial and boundary conditions, D'Alembert's solution of the wave equation.

Text and reference books:

1. Dev Raghvendra et al., *Ordinary Differential Equations*, Tata McGraw Hill.

2. A Chakrabarti, *Elements of Ordinary Differential Equations and Special Functions*, Wiley, 1990.

3. C.R.Mondal, *Text book of Ordinary Differential Equation*, PHI Learning, 2008.

4. K.Sankara Rao, *Introduction to Partial Differential Equations*, PHI learning Pvt. Ltd.

5. P Prasad and R Ravindran, *Partial Differential Equations*, New Age International, 2011.

6. T. Amaranath , *An Elementary Course in Partial Differential Equations*, Narosa, New Delhi.

MAT -413 Number Theory 3L 3 Credits

Divisibility: basic definition, properties, prime numbers, some results on distribution of primes.

Congruences: basic definitions and properties, complete and reduced residue systems, theorems of Fermat, Euler & Wilson, application to RSA cryptosystem. Linear congruences and Chinese remainder theorem, quadratic congruences, and Quadratic Reciprocity law.

Arithmetical functions: examples, with some properties and their rate of growth.

Diophantine Approximation: Continued fractions and their connection with Diophantine approximations, applications to Pell's equations.

Diophantine Equations: Linear equations, Binary quadratic forms, Solutions of some quadratic and higher degree diophantine equations.

Partitions: Partitions of a number, Some basic properties and results.

Text and reference books:

1. David Burton, *Elementary Number Theory*, McGraw Hill Edu. 2006.
2. I. Niven, Herbert S. Zuckerman, Hugh L. Montgomery, *An introduction to the theory of numbers*, 5e, Wiley, 1991.
3. Alan Baker, *A concise introduction to the theory of numbers*, Cambridge Univ. Press, 1984.
4. G.H. Hardy & E.M. Wright, *An introduction to the theory of numbers*, 4th Editions, Oxford, Univ. Press, 1960.

MAT-414 Measure Integral and Probability 3L 3 Credits

Measurable spaces, measurable sets, measurable functions, measure, outer measures and generation of measure, Lebesgue integration, basic integration theorem, comparison of Lebesgue and Riemann integrals.

Various modes of convergence of measurable functions, signed measure, Hahn and Jordan decomposition theorems, the Radon-Nikodym theorem, product measures and Fubini's theorem.

Probability measures and spaces, independent events, conditional probability, theorem of total probability, random variables, distribution and distribution function of a random variable, independent random variable, expectation, convergence in distribution of a sequence of random variables, I.I.D. random variables, weak and strong laws of large numbers, Kolmogorov's zero-one law, the central limit theorem, identically distributed summands, the Linderberg and Lyapounov theorems.

Text and reference books:

1. R. G. Bartle, *The elements of integration and Lebesgue Measure*, Wiley, 1966.
2. P. Billingsley, *Probability and Measure*, 3e, Wiley, 1995.
3. K. L. Chung, *A course in probability theory*, 3e, Academic Press, 2001.
4. H. L. Royden, P. Flitzpatrick, *Real Analysis*, 4e, Prentice Hall, 2010.

MAT- 415 Random Variables & Stochastic Process 3L 3 Credits

Random Variables: Discrete & continuous random variables and their event space, statistical averages, computation of mean time to failure, moment generating functions.

Two dimensional random variables: joint probability mass function, density functions, joint probability distribution functions, marginal probability distribution, conditional probability distribution & conditional expectation function involving more than one random variables.

Stochastic Processes: Classification, analytical representation of a stochastic process, autocorrelation function & its properties ,the Bernoulli process, the Poisson process, pure birth, pure death & birth-death process, Mathematical models for M/M/1, M/M/1/N, M/M/S, M/M/S/N queues.

Text and reference books:

1. Sundarapandian.V., *Probability, Statistics and Queuing Theory*, PHI, 2009.
2. V.G. Kulkarni, *Modeling and Analysis of Stochastic Systems*,
3. U.N. Bhat, *Elements of Applied Stochastic Processes*.
4. J. Medhi, *Stochastic Models in Queueing Theory*-