SYLLABUS & PROGRAMME STRUCTURE

M.Sc.

in

Applied Mathematics

(Choice Based Credit System)

(Effective from the Academic Session 2017-2018)

DEPARTMENT OF APPLIED MATHEMATICS
MAHARAJA BIR BIKRAM UNIVERSITY
AGARTALA, TRIPURA: 799004

Maharaja Bir Bikram University

APPLIED MATHEMATICS Syllabus

M.Sc.Course (Two years)

Outline of the Syllabus with effect from 2017-2018

Course Code	*Course Title*	*Marks*	*Credit*
First Semester			
APPMAT-101	**Algebra - I**	**50**	**4**
APPMAT-102	**Real Analysis**	**50**	**4**
APPMAT-103	**Classical Mechanics**	**50**	**4**
APPMAT-104	**Differential Geometry and Tensors**	**50**	**4**
Second Semester			
APPMAT-201	**Algebra - II**	**50**	**4**
APPMAT-202	**Functional Analysis**	**50**	**4**
APPMAT-203	**Ordinary and Partial Differential Equations**	**50**	**4**
APPMAT-204	**Continuum Mechanics**	**50**	**4**
Third Semester			
APPMAT-301	**Topology**	**50**	**4**
APPMAT-302	**Complex Analysis**	**50**	**4**
APPMAT-303	**Numerical Analysis with Computer Applications**	**50 (30-Theory + 20-Practical)**	**6 (3+3)**
Choose any ***one (1)*** of the following *Special Papers*			
APPMAT-304	**Bio Mathematics-I**	**50**	**4**
APPMAT-305	**Operation Research-I**	**50**	**4**

APPMAT-306	**Mathematical Elasticity-I**	**50**	**4**
APPMAT-307	**Fluid Dynamics-I**	**50**	**4**
Fourth Semester			
APPMAT-401	**Mathematical Methods**	**50**	**4**
APPMAT-402	**Advanced Numerical Analysis with Computer Applications**	**50 (20-Theory + 30-Practical)**	**6 (3+3)**
APPMAT-403	**Project**	**50**	**5**
Choose any ***one(1)*** of the following *Special Papers* (* **Choice of papers:** APPMAT-304 → APPMAT-404; APPMAT-305 → APPMAT-405; APPMAT-306 → APPMAT-406; APPMAT-307 → APPMAT-407)			
APPMAT-404	**Bio Mathematics-II**	**50**	**4**
APPMAT-405	**Operation Research-II**	**50**	**4**
APPMAT-406	**Mathematical Elasticity-II**	**50**	**4**
APPMAT-407	**Fluid Dynamics-II**	**50**	**4**

Maharaja Bir Bikram University
Department of Applied Mathematics
First Semester Syllabus

APPMAT-101	**Algebra - I** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-102	**Real Analysis** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-103	**Classical Mechanics** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-104	**Differential Geometry and Tensors** Marks-50 (End term 40+ Internal 10) Credit-4

Detailed Syllabus

Course Title: Algebra-I
Course No: APPMAT-101

Groups: Homomorphism of groups, Normal Subgroups, Quotient groups, Isomorphism Theorems, Cayley's Theorem.
Generalised Cayley's Theorem, Cauchy's Theorem, Group Action, Sylow Theorems, and their applications.
Normal and Subnormal series, Composition series, Solvable groups and nilpotent groups, Jordan-Holder theorem and it's applications.

Rings: Ideals and Homomorphism, Prime and Maximal Ideals, Quotient Field and Integral Domain, Polynomial and power series Rings.
Divisibility Theory: Euclidean Domain, Principal Ideal Domain, Unique Factorization Domain, Gauss Theorem.
Noetherian and Artinian Rings, Hilbert Basis Theorem, Chhen's Theorem.

Modules: Left and Right Modules over a ring with identity, Cyclic Modules, Free Modules, Fundamental structure theorem for finitely generated modules over a PID and it's application to finitely generated abelian groups.

References :

1. Dummit D.S., Foote R.M., Abstract Algebra, Second Edition, John Wiley & Sons. Inc., 1999.
2. Goldhaber J.K., Ehrlich G., Algebra, The Macmillan Company, Collier-Macmillan Limited, London.
3. Herstein I.N., Topics in Abstract Algebra, Wiley Eastern Limited.
4. Hungerford T.W., Algebra, Springer.

Course Title: Real Analysis
Course No: APPMAT-102

Bounded Variation

Functions of bounded variation and their properties. Differentiation of a function of bounded variation. Absolutely continuous function, representation of an absolutely continuous function by an integral.

Measure on the Real line

Lebesgue outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability. Convergence in measure. Sequence of measurable functions and their properties. Almost uniform convergence.

Lebesgue Integral

Definition, examoles and different properties. Indefinite Lebesgue Integral and their properties.

References :

1. Aliprantis, C.D., Burkinshaw, O., Principles of Real analysis, 3rd Edition, Harcourt Asia Pte Ltd., 1998.
2. Royden, H.L., Real Analysis, 3rd Edition, MacMillan, New York and London, 1988.
3. Halmos, P.R., Measure Theory, Van Nostrand, New York, 1950.
4. Rudin, W., Real and Complex Analysis, MCGraw-Hill Co., 1966.
5. Kolmogorov, A.N., Fomin, S.V., Meassures, Lebesgue Integrals and Hillbert Space, Academic Press, New Yorkand London, 1961.

Course Title: Classical Mechanics

Course No: APPMAT-103

A brief recapitulation of Newton's laws and related properties, Generalized Coordinates, Virtual work, D'Alembert's principle, Unilateral and bilateral constraints, Holonomic and Non-holonomic systems, Seleronmic and Rhenomic systems, Lagrange's equation of first and second kind, Uniqueness of solution, Energy equation for conservative field, Euler's dynamical equations, Rotating coordinate system, Motion related to rotating Earth, Faucaull's pendulum and torque free motion of a rigid body about a fixed point, Motion of a symmetrical top and theory of small vibrations.

Hamilton's variable, Hamilton's canonical equation, Homogeneity of space and time conservation principle, Noether'stheorem, Cyclic coordinates, Routh's equations, Hamilton's principle, Principle of least action, Poisson's bracket, Poisson's identity, Jacobi-Poisson theorem.

Time dependent Hamilton-Jacobi equation and Jacobi's theorem, Lagrange brackets, Condition of canonical character of transformation in terms of Lagrange brackets and Poisson brackets, Invariance of Lagrange brackets and Poisson brackets under canonical transformations.

References:

1. H. Goldstein, *Classical Mechanics.*
2. N. C. Rana *and* P. S. Jog, *Classical Mechanics.*
3. L. N. Hand *and* J. D. Finch, *Analytical Mechanics.*
4. A. S. Ramsey, *Dynamics Part-II,*
5. S. L. Loney, *Rigid Dynamics.*
6. Gupta, Kumar, Sharma, *Classical Mechanics.*
7. A. B. Gupta, *Classical Mechanics and properties of matter*.

Course Title: Differential Geometry and Tensors
Course No: APPMAT-104

Tensors :

Linear vector spaces, linear transformation and matrices, reduction of matrices to the quadratic forms, classification and properties of quadratic forms.

Scope of tensor analysis, invariants, tensor and their transformation laws, transformation of coordinates, properties of admissible transformation of coordinates, transformation by covariance and contravariance tensor, concept of covariance and contravariance tensors, algebra of tensors, quotient laws, symmetric and skew symmetric tensors, relative tensors, metric tensors, fundamental and associated tensors.

Christoffels' symbols, transformation of Christoffels' symbols, Covariant differentiation of tensors and formula, Ricci's theorem, Rieman-Christoffels' tensors, Ricci tensor, Riemannian and Euclidean space, Existence theorem. The e-system and the generalized Kronecker's deltas.

Curves in Space:

Parametric representation of curves, Helix, Curvilinear coordinates in E_3. Tangent and first curvature vector, Frenet formulas for curves in space, Frenet formulas for curve in E_n. Intrinsic differentiation, Parallel vector fields, Geodesic.

Surfaces :

Parametric representation of a surface, Tangent and Normal vector field on a surface, The first and second fundamental tensor, Geodesic curvature of a surface curve, The third fundamental form, Gaussian curvature, Isometry of surfaces, Developable surfaces, Weingarten formula, Equation of Gauss and Codazzi , Principal curvature, Normal curvature, Meusnier's theorem.

References :

1. Sokolnikoff, I.S., Tensor Analysis, Theory and Applications to Geometry and Mechanics : (chapter-II and III) , John Wiley & Sons Inc N.T.
2. Wilmore, T.T., An Introduction to Differential Geometry: (chapter – I,II,III,V andVI)
3. BARYSPAIN, Differential Geometry.
4. Goreux, F.F., Differential Geometry, New Central Book Agency, Kolkata-9.
5. Chakraborty, A.K., Elementary Analysis, Ram Prasad & Sons, Agra-3.
6. Das Dilip Kumar, Tensor Calculus, Dasgupta Publisher, Kolkata-9.
7. De, U.C., Shaikh, A.A., Sengupta, J., Tensor Calculus, Narosa Publishing House, New Delhi.
8. Chaki, M.C., Tensor Calculus, Calcutta Publisher, Kolkata-9.

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Second Semester Syllabus

APPMAT-201	**Algebra-II** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-202	**Functional Analysis** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-203	**Ordinary and Partial Differential equations** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-204	**Continuum Mechanics** Marks-50 (End term 40+ Internal 10) Credit-4

Course Title: Algebra II
Course No: APPMAT-201

Fields, Finite fields, Extension fields, algebraic and transcendental extension, separable and normal extensions, perfect fields, algebraically closed fields.

Galois Group of automorphisms and Galois Theory, Solution of polynomial equations by radicals, Insolvability of the general equation of degree 5(or more) by radicals.

The minimal polynomial, Diagonalizable and triangulable operators, Primary Decomposition theorem, Secondary decomposition theorem,The Jordan Form, The Rational Form,

Norms of vectors and matrices, Transformation of matrices, adjoint of an operator, normal, unitary, Hermitian and skew-Hermitian operators.

Bilinear Forms, Definition and examples, symmetric and skew-symmetric bilinear forms, real quadratic forms, The matrix of a bilinear form, Orthogonality, Classification of bilinear forms.

References:

1. Hoffman and Kunze, LinearAlgebra.
2. Rao A.R., Bhimashankaram P., Linear Algebra. (Tata Mc-GrawHill)
3. M. Artin, Algebra, Prentice Hall ofIndia.
4. Gilberd Strang; Linear Algebra and its Application, Academicpress.
5. S. Lang, Linear Algebra, Undergraduate Texts in Mathematics,Springer-Verlag.
6. P. Lax, Linear Algebra, John Wiley &Sons.
7. Ben Noble and james W. Daniel; Applied Linear Algebra (Prentice - Hall of India privateLtd.)
8. Gareth Williams, Linear Algebra with applications, Narosa PublishingHouse.
9. Goldhaber, J.K., Ehrlich, G., *Algebra*, The Macmillan Company, Collier-Macmillan Limited, London.
10. Herstein, I.N., *Topics in Abstract Algebra*, Wiley Eastern Limited.

Course Title: Functional Analysis
Course No: APPMAT-202

Metric space, Definition and examples of spaces like R^n, C^n, l_n^p, l^p, continuity, Cauchy sequence, completeness and completion of metric spaces, Normed linear space, Banach space, Quotient space, Normed linear spaces and their completeness, equivalent spaces

Fixed point theorem, Inner product space, Hilbert space, orthonormal sets, Bessel's inequality, Perseval identity, Uniform boundedness theorem, open mapping theorem, dual space, reflexivity of Banach space

Reference:

1.Goffman C Pedrick, First Course in Functional Analysis, Prentic Hall of India, New Delhi
2.LimayeB.V , Functional Analysis, Wiley Eastern Ltd
3. B. K. Lahiri, Functional Analysis, World Press Calcutta

Course Title: Ordinary and partial Differential Equations
Course No: APPMAT-203

Group-A

ORDINARY DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS

Initial value problem of first order ODEs, Existence and Uniqueness of solutions of IVP, Singular solution, General theory of homogeneous and non homogeneous linear ODE, Variation of parameters,Sturn-Liouville Boundary Value Problem, Green's Function. Ascoli-Arzoli theorem, Theorem on convergence of solution of IVP, Picard –Lindelofftheorem, Piano's Existence Theorem, Systems of first order ODEs, Independence of the solution of linear differential equation, Wronskian and its properties, exact differential equation and equation of special form.Adjoint and self-adjoint equations

Series solution by the method of Frobenius, Hypergeometric equation and Hypergeometric functions, Legendre differential equation andLegendre polynomials, Bessel's differential equation and Bessel's function. Laguerre differentialequation and Lagurre polynomial, Hermite differential equation and Hermite polynomial;recurrence relations, orthogonal properties.

Group-B

PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations, Pfaffian differential equations - Quasi-linear equations,Lagrange'smethod,Charpit'smethod,Solution of higher order partial differential equation with constant coefficients, Cauchy problem for first order partial differential equations.
Classification of second order PDE's, Linear PDE with constant coefficients, reducible and irreducible equations. Different methods of solution. Second order PDE with variable coefficients. Characteristic curves of second order PDE. Reduction to canonical forms.D'Alembert's solution of wave equation.Solutions of PDE of second order by the method of separation of variables.

Reference:

1. Simmons, G. F. Differential Equations with Applications and Historical Notes,(McGraw Hill, 1991).
2. Codington and Levison, Theory of Ordinary Differential equations, Tata McGrawHill
3. Ian Sneddon, Elements of Partial Diff.Equations
4. Hartman, P , Ordinary differential equation , John wiley and sons
5. Reid , W.T . Ordinary differential equation , John wiley and sons .
6. Rao, K.S. Introduction to partial differential equations (Prentice Hall of India, New Delhi, 2006).
7. Burkhill , J .C ., Theory of ordinary differential equation

Course Title: Continuum Mechanics

Course No. : APPMAT-204

Group-A

Stress and Strain Analysis

Analysis of strain: Affine transformation, infinitesimal affine transformation. Ageometrical interpretation of components of strain.Strain quadric of Cauchy.Transformation of strain component by changing the co-ordinate system. Principlestrains, invariants, general infinitesimal deformation, compatibility equations, linearstrain. Examples of strain.Finite deformation.
Analysis of stress: Body and surface force, specification pf stress at a point, equationof equilibrium, symmetry of stress tensor, boundary conditions, transformation ofstress components from an co-ordinate to another and stress invariants. Stressquadric. Mohr's diagram, mean stress, stress ellipsoid. Octahedral, normal andshearing stresses. Purely normal stress.Examples of stress.Different formulae.

Group-B

Fluid Mechanics

Fluid motion byEuler and Lagrangian method,Equivalence of thesetwo methods, different types of flows, stream lines and path lines, difference between them, velocity pottential, rotational and irrotational motion, equation of continuity by Euler and lagrange, particular case of equation of motion, condition for a surface to be a boundary surface, simple problems.
Eulers dynamical equations, surface condition integration of the equation of motion, Bernoulli's theorem, equation of motion by flux method, Lagranges hydrodynamical equation, Cauchy's integral, Performancy of irrotational motion, Helmotz's equation, Kelvin's circulation theorem, simple problems.
Motion in two dimensions, the current function, irrotational motion, source, sink and doublet, complex potential, image of a source w.r.t plane and a circle, image of a doublet w.r.t to a circle, simple problems
Vorticity, properties of vortex filament, complex potential due to a rectilinear vortex, image of a vortex w.r.t a plane, circular cylinder, two infinite rows of vortices, Karman's vortex sheet

References:
1. I.S.Sokolnikoff : Mathematical Theory of Elasticity , Tata Mc. Grawhill , 1997.
2. S.Valliappan : Continuum Mechanics , Oxford & IBH Publishing Co.1981
3. P.D.S Verma :Theory of elasticity,Vikas Publishing House PVT LTD
4. F.Charlton: Textbook of Fluid Dynamics, CBS Publishers, Delhi, 1985
5. A.J.ChoinandA.Morsden : A Mathematical Int, to Fluid Dynamics, Springer Verlag,1993
6. L.D.Landau and E.M.Lipschitz : Fluid Mechanics, Pergamon Press, London, 1985.

Maharaja Bir Bikram University
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Third Semester Syllabus

APPMAT-301	**Topology** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-302	**Complex Analysis** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-303	**Numerical Analysis with Computer Applications** Marks-50 (Theory-30+Practical-20) Credit-6 (3-Theory+3-Practical)
Choose any one (1) of the following Special Papers	
APPMAT-304	**Bio Mathematics-I** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-305	**Operation Research-I** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-306	**Mathematical Elasticity-I** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-307	**Fluid Mechanics-I** Marks-50 (End term 40+ Internal 10) Credit-4

Detailed Syllabus

Course Title: Topology
Course No: APPMAT-301

1. Basic concepts: Open and closed sets, bases and sub-bases for open sets and for closed sets Topological structures, accumulation points, closure of a set, interior, exterior, boundary, neighborhood & neighborhood system, Product topology on $X \times Y$, convergence and limit, coarser and finer topologies, subspaces, relative topologies, equivalent definition of topologies.
2. Continuity of functions, quotient spaces, continuity at a point, sequential continuity at a point, open and closed functions, topological properties, topologies induced byfunctions, homeomorphism,
3. Separation by open sets, separation axioms and Ti spaces, subspaces, sum, product and quotient spaces, Urysohn's lemma and Metrization theorem, regular space,completely regular spaces, normal space, Tychonof space, completely normal, Housdroff space.
4. First countable spaces, second countable spaces, separation spaces and Lindeloff theorem, hereditaryproperties.
5. Covers, open covers, finite sub covers compact sets, reducible compact sets, sub set of a compact space, finite intersection property, compactness and Hausdorff spaces, sequentially compact sets, locally compactsets, finite intersection property, Heine-Borel, Lindelof space, locally compact, Bolzano Weirestrass property, sequentially compact, compactness for continuous image, compactness for metric space.
6. Separated sets, connected sets, connected spaces, connectedness on the real lines.
7. Cauchy sequence, contraction map, nested sequence, Baire's category theorem, fixed point theorem.

References :

1. Munkres, J.R., *Topology, A First Course*, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. Dugundji, J., *Topology*, Allyn and Bacon, 1966.
3. Simmons, G.F., *Introduction to Topology and Modern Analysis*, McGraw-Hill, 1963. Kelley, J.L., *General Topology*, Van Nostrand Reinhold Co., New York, 1995.
4. Hocking, J., Young, G., *Topology*, Addison-Wesley Reading, 1961.
5. Steen, L., Seebach, J., *Counter Examples in Topology*, Holt, Reinhart and Winston, New York, 1970.

Course Title: Complex Analysis
Course No: APPMAT-302

Cauchy-Riemann equations, Bilinear transformation, Harmonic functions, Cauchy-Goursat theorem, Cauchy integral formula, Morera's theorem, Cauchy inequality, Liouville's theorem, Maximum modulus theorem, Fundamental theorem of algebra, Rouche's theorem,Conformal mapping, Sequence and Series of complex number and their convergence.

Power Series, Taylor, Laurent series, Singularities, Schwarz lemma, Residue theorem, Contour integration, Analytic continuation, Gamma function and its contour representation.

Reference:

1. J.B Conway, Function of one complex variable, Narosa publication
2. H.S Kasana, Complex Variable, Prentic Hall of India
3. S. Punnuswamy, Functions of complex analysis, Narosa
4. E.T Copson, An introduction to theory of functions of complex variable, Oxford Clarendon Press, 1962
5. T.M Mac Robert, Functions of a Complex variables, Macmillan, 1962

Course Title: Numerical Analysis with Computer Applications
Course No: APPMAT-303

Numerical Analysis Theory:

System of linear equations and eigenvalue problem: Operational counts for direct methods of solving system linear algebraic equations. Gaussian operational count for inversion of a matrix. Eigenvalue problem. General iterative method. Jacobi and Gauss. Seidel method. Relaxation method. Necessary and sufficient conditions for convergence. Speed of convergence. S.O.R. and S.U.R. methods. Gerschgorin's circle theorem. Determination of eigenvalue by iterative methods, Ill conditioned system.

System of non-linear method equations: Newton's method. Existence of roots. Stability and convergence under variation of initial approximations. General iterative method for the system: x = g(x) and its sufficient condition for convergence. The method of steepest descent.

Finite difference method: Solution of partial differential equations by finite difference method. Partial difference quotients. Discretization error. Idea of convergence and stability. Explicit and Crank- Nicolson implicit method of solution of one dimensional heat conduction equation: convergence and stability. Standard and diagonal five point formula for solving Laplace and Poission equations. Explicit and Implicit method of solving Cauchy problem of one- dimensional wave equation. CFL conditions of stability and convergence. Finite difference approximations in polar coordinates.

***Numerical Analysis Practical*:**

1. Gauss-Jordon method.
2. Inverse of a matrix
3. S.O.R. / S.U.R. method
4. Relaxation method
5. Solution of one dimensional heat conduction equation by
    i) Explicit and
    ii) Crank-Nicolson implicit method.
6. Solution of Laplace equation.
7. Solution of Poisson equation.
8. Solution of one-dimensional wave equation.

References:

1. *Computing methods;* Berzin and Zhidnov.
2. *Analysis of Numerical methods:* Isacson and Keller.
3. *A first course in Numerical Analysis:* Ralston and Rabinowitz.
4. *Numerical solution of differential equations:* M.K.Jain.
5. *Numerical solution of partial differential equations:* G.D.Smith.
6. *The finite element method in structural and continuum mechanics:* O.C.Zienkiewics.
7. *The finite elements method in partial differential equations:* A.R.Mitchell.
8. *An introduction to boundary element methods:* Prem K. Kytbe.
9. *Computational Mathematics:* B.P.Demidovich and J.A.Maron.
10. *Applied Numerical Methods:* A. Gourdin & M. Boumahrat.

Course Title: Biomathematics-I
Course No: APPMAT-304

Qualitative Theory of Linear and Nonlinear systems:

Linear systems:
Linear autonomous systems, existence, uniqueness and continuity of solutions, diagonalization of linear systems, fundamental theorem of linear systems, the phase paths of linear autonomous plane systems, complex eigen values, multiple eigen values, similarity of matrices and Jordon canonical form, stability theorem, reduction of higher order ODE systems to first order ODE systems, linear systems with periodic coefficients.

Nonlinear systems:
The flow defined by a differential equation, linearization of dynamical systems (two, three and higher dimension), Stability: (i) asymptotic stability (Hartman's theorem), (ii) global stability (Liapunov's secondmethod).

Periodic Solutions (Plane autonomous systems):
Translation property, limit set, attractors, periodic orbits, limit cycles and separatrix, Bendixon criterion, Dulac criterion, Poincare-Bendixon Theorem, index of a point, index at infinity.

Bifurcation and Center Manifolds:
Stability and bifurcation, saddle-node, transcritical and pitchfork bifurcations, hopf- bifurcation, center manifold (linear approximation).

Linear difference equations:
Difference equations, existence and uniqueness of solutions, linear difference equations with constant coefficients, systems of linear difference equations, qualitative behavior of solutions to linear difference equations.

Nonlinear difference equations (Map):
Steady states and their stability, the logistic difference equation, systems of nonlinear difference equations, stability criteria for second order equations, stability criteria for higher order system.

Chaos:
One-dimensional logistic map and chaos.

References:

1. D. W. Jordan and P. Smith (1998): Nonlinear Ordinary Equations- An Introduction to Dynamical Systems (Third Edition), Oxford Univ.Press.
2. L. Perko (1991): Differential Equations and Dynamical Systems, SpringerVerlag.
3. F. Verhulust (1996): Nonlinear Differential Equations and Dynamical Systems, Springer Verlag.
4. Alligood, Sauer, Yorke (1997): Chaos- An Introduction to Dynamical Systems, Springer Verlag.
5. W. G. Kelley and A. C. Peterson (1991): Difference Equations- An Introduction with Applications, AcademicPress.

Course Title: Operation Research-I
Course No: APPMAT-305

Goal Programming

Introduction, Concept of Goal Programming, Difference between LP & GP approach, Graphical solution-method of GP, Modified simplex method of GP.

Dynamic programming

Introduction, Characteristic of Dynamic programming, Deterministic and Probabilistic Dynamic Programming, Bellman's principle of optimality, solving linear and non-linear programming problems.

Travelling Salesman Problem

Origin of travelling salesman problem, Symmetrical and asymmetrical problems, Mathematical representation of problems, Solution techniques for such problems using zero assignment/unit assignment etc.

Theory of Games

Introduction.Basic idea of theory of games. Payoff matrix. Rectangular games, Strategies, Pure and Mixed strategy problems, Minimax/Maximin criterion, Saddle point, Graphical method of solving 2 x n and m x 2 games, Dominance principle, Equivalence of rectangular games and solving games by linear programming and matrix method.

Queueing Theory

Introduction, Queueing system, Queue disciplines FIFO, LIFO, SIRO, FILO etc. The Poisson process (Pure birth process), Arrival distribution theorem, Properties of Poisson process, Distribution of inter arrival times (exponential process), Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space.

References:

1. Operations Research - S.D.Sharma
2. Operations Research - Kanti Swarup, P.K. Gupta andManmohan
3. OR methods and Problems - Sasieni Maurice, Arther Yaspan, LawrenceFriedman
4. Operations Research - H.S. Taha
5. Introduction to Operations Research,McGraw-Hill,1995, F.S.Hiller & G.C.Leiberman.
6. Nonlinear and Dynamic Programming, AddisonWesley, G.Hadly.
7. Operations Research: Theory and Applications, McMillan,2013, K. Sharma.

Course Title: Mathematical Elasticity-I
Course No: APPMAT-306

Equations of Elasticity : Equations of equilibrium motion in terms of sisplacements,Hooke's law. Generalized Hooke's law.Various cases of Elastic symmetry of a body. The strain energy function and its connection with Hooke's law. Betti's identity. Clapeyrons formula and Clapeyrons theorem. Fundamental boundary value problems. Uniqueness and existence of solutions. Saint Venant's principle.

Inverse and semi-inverse methods of solution :.Extension, Bending, Torsion and Flexure of beams : Solution of torsion problem as Dirichlet or Neumann boundary value problem. Prandtl's Analogy. Conformal mapping and the general problem of Flexure. Transverse bending. Problem of Torsion and Flexure for circular and elliptic bar. Torsion of circular shafts of variable diameter.

Plane problems : Plane strain and plane stress. Generalized plane stress. Airy's stress function. Solution of plane problems by means of polynormials. General Equations of the plane problems in polar co ordinates.

Thermo elasticity : Stress-strain relations, Differential equations of heat conduction, Basic equation in dynamical thermo elasticity, Thermo elastic vibrations and waves.

References:

1. A Treatise on The Mathematical Theory of Elasticity – A. E.Love
2. Mathematical Theory of Elasticity - I. S.Sokolnikoff
3. Theory of Elasticity – S. Timoshenko and J. N.Goodier
4. Elasticity Theory and Applications – A. S.Saada
5. Foundations of Solid Mechanics – Y. C.Fung
6. Theory of Elasticity – Y. A.Amenzade
7. Applied Elasticity – ZhilunXu
8. Wave Propagations in Elastic Solids – J. D.Achenbach
9. Elasto-dynamics – A. C.Eringen
10. Wave Motion in Elastic Solids – K. F.Graff
11. Applied Elastity – Chi-TheWang.

Course Title: Fluid Dynamics-I
Course No: APPMAT-307

Bernoulli"s equation. Impulsive action equations of motion and equation of continuity in orthogonal curvilinear co- ordinate. Euler's momemtum theorem and D'Alemberts paradox.

Theory of irrotational motion flow and circulation. Permanence irrotational motion. Connectivity of regions of space. Cyclic constant and acyclic and cyclic motion. Kinetic energy. Kelvin's minimum. Energy theorem. Uniqueness theorem.
Dimensional irrotational motion.

Function. Complex potential, sources. sinks, doublets and their images circle theorem. Theorem of Blasius. Motion of circular and elliptic cylinders. Circulation about circular and elliptic cylinder. Steady streaming with circulation. Rotation of elliptic cylinder.
Theorem of Kutta and Juokowski. Conformal transformation. Juokowski transformation. Schwartz-chirstoffel theorem.

Motion of a sphere. Stoke's stream function. Source, sinks, doublets and their images with regards to a plane and sphere.
Vortex motion. Vortex line and filament equation of surface formed by stream lines and vortex lines in case of steady motion. Strength of a filament. Velocity field and kinetic energy of a vortex system. Uniqueness theorem rectilinear vortices. Vortex pair. Vortex doublet. Images of a vortex with regards to plane and a circular cylinder. Angle infinite row of vortices. Karman's vortex sheet
Waves: Surface waves. Paths of particles. Energy of waves. Group velocity. Energy of a long wave.

References:

1. Hydrodynamics–A.S.Ramsay(Bell)
2. Hydrodynamics – H.Lamb(Cambridge)
3. Fluid mechanics – L.D.Landou andE.M.Lifchiz(Pergamon),1959
4. Theoritical hydrodynamics–L.M.Thomson
5. Theoritical aerodynamics –I.M.Milne-Thomson;Macmillan,1958
6. Introduction to the theory of compressible flow –Shih-I.Pai; Van Nostrand,1959
7. Inviscid gas dynamics – P.Niyogi, Mcmillan,1975(india)
8. Gas dynamics – K.Oswatitsch(english tr.) academic press,1956

Maharaja Bir Bikram University
Department of Applied Mathematics
Fourth Semester Syllabus

APPMAT-401	**Mathematical Methods** **Marks-50 (End term 40+ Internal 10) Credit-4**
APPMAT-402	**Advanced Numerical Analysis with Computer Applications** **Marks-50 (Theory-20+Practical-30) Credit-6 (3-Theory+3-Practical)**
APPMAT-403	**Project** **Marks-50 (End term 40+ Internal 10) Credit-5**
Choose any One(1) of the following Special Papers (* **Choice of papers:** APPMAT-304 → APPMAT-404; APPMAT-305 → APPMAT-405; APPMAT-306 → APPMAT-406; APPMAT-307 → APPMAT-407)	
APPMAT-404	**Bio Mathematics-II** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-405	**Operation Research-II** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-406	**Mathematical Elasticity-II** Marks-50 (End term 40+ Internal 10) Credit-4
APPMAT-407	**Fluid Dynamics-II** Marks-50 (End term 40+ Internal 10) Credit-4

Detailed Syllabus

Course Title: Mathematical Methods
Course No: APPMAT-401

1. **IntegralTransforms:**Fourier transform: Existence, Uniqueness, Inversion, Applications to ODE &PDE, Fourier integral Theorem, Fourier transform of the derivative. Derivative of Fourier transform. Fourier transforms of some useful functions. Fourier cosine and sine transforms. Convolution. Properties of convolution function. Convolution theorem.

Hankel Transforms and its inverse. Application to Boundary value problems.

Z-transform : Definition and properties. Z-transform of some standard functions. Inverse Z-transforms.Applications.

2. **Calculus of Variations:** Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema.Variational methods for boundary value problems inordinary and partial differentialequations.

3. **Integral Equations :** Introduction. Linear integral equations of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Relation between integral equations and initial boundary value problems.

Existence and uniqueness of continuous solutions of Fredholm and Volterra's integral equations of second kind. Solution by the method of successive approximations. Iterated kernels. Reciprocal kernels. Volterra's solution of Fredholm's integral equation. Fredholm theory for the solution of fredholm's integral equation. Fredholm's determinant D(lamda). Fredholm's first minor D(x,y,lamda) Fredholm's first and second fundamental relations. Fredholm's p-th minor. Fredholm's first, second and third fundamental theorems. Fredholm'salternatives. Hilbert-Schmidt theory of symmetric kernels. Properties of symmetric kernels. Existance of characteristic constants. Complete set of characteristic constantsand complete orthonoralmised system of fundamental functions. Expansion of iterated kernel in terms of fundamental functions. Schmidt's solution of Fredholm's integral equations.

References:

1. Brown J. W. and Churchill, R. Fourier Series and Boundary Value Problems (McGraw Hill,1993).
2. Roach, G. F. Green's Functions (Cambridge University Press,1995).
3. Gupta, A, S. Calculus of Variations with Applications (Prentice Hall of India, New Delhi 2003).
4. Mikhlin, S. G. Integral equations (The MacMillan Company, New york,1964).
5. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and Their Applications (Chapman &Hall/CRC).
6. Lovitt : Linear Integral Equations.
7. Tricomi : IntegralEquations.

Course Title: **Advanced Numerical Analysis with Computer Applications**
Course No: APPMAT-402

Advanced Numerical Analysis Theory

Numerical solution of integral equations: Approximate solution of Fredholm equation by finite sums and degenerateKernels. Numerical approximation of Volterra equations.

Finite element and Boundary element methods: Weighted residual method: Galerkin, Least square, partition, moment and colloction methods. Solution of boundary value problems by Ritz method. Finite elements and boundary elements of various terms. Constant elements by Gaussian quadrature. Numerical integration over finite elements. Solution of boundary value problems by Finite element and Boundary element methods.

Advanced Numerical Analysis Practical

1. Solution of ordinary differential and partial differential equation by weighted Residual method:
    a. Least square method.
    b. Galerkin method.
2. Solution of simple boundary value problem by
    a. Finite element and
    b. Boundary element method.
3. Solution of system of Non-linear equations by Newton‟s method.
4. Method of steepest descent.

References:

1. *Computing methods;* Berzin and Zhidnov.
2. *Analysis of Numerical methods:* Isacson and Keller.
3. *A first course in Numerical Analysis:* Ralston and Rabinowitz.
4. *Numerical solution of differential equations:* M.K.Jain.
5. *Numerical solution of partial differential equations:* G.D.Smith.
6. *The finite element method in structural and continuum mechanics:* O.C.Zienkiewics.
7. *The finite elements method in partial differential equations:* A.R.Mitchell.
8. *An introduction to boundary element methods:* Prem K. Kytbe.
9. *Computational Mathematics:* B.P.Demidovich and J.A.Maron.
10. *Applied Numerical Methods:* A. Gourdin & M. Boumahrat.

Course Title: Biomathematics-II
Course No: APPMAT-404

The nature of ecosystems, Autotroph-based ecosystem, Detritus-based ecosystem, Different types of population growth, Community dynamics- succession and community responses.

Single Species Population Dynamics:
Continuous growth models – their stability analysis, Influence of random perturbations on population stability. Insect out break model- Spruce-Budworm model. General autonomous models. Delay Models.

Population Dynamics of Two Interacting Species:
Introduction, Lotka-Volterra system of predator-prey interaction, Trophic function, Gauss's Model, Gause Model, Kolmogorov Model, Leslie Gower Model, Analysis of predator-prey model with limit cycle periodic behavior, parameter domains of stability. Competition models- exclusion principle and stability analysis. Models on mutualism.

Continuous models for three or more interacting species:
Three species simple and general food chain models- its stability and persistence. Models on one prey two competing predators with limited resources and living resource supporting three competing predators- stability analysis and persistence.

Deterministic Epidemic Models:
Deterministic model of simple epidemic, Infection through vertical and horizontal transmission, General epidemic- Karmac-Mackendric Threshold Theorem, Recurrent epidemics, Seasonal variation in infection rate, allowance of incubation period, models with undamped waves, modeling of Venereal diseases, Simple model for the spatial spread of an epidemic.

Population Models in Epidemic:
Introduction, Parasite-host system, an SIS model, an SIR model and an SIRS model. SIS model with proportional mixing rate, SIRS model with proportional mixing rate.

References:

1. H. I. Freedman - Deterministic Mathematical Models in Population Ecology
2. Mark Kot (2001): Elements of Mathematical Ecology, Cambridge Univ. Press.
3. D. Alstod (2001): Basic Populas Models of Ecology, Prentice Hall, Inc., NJ.
4. N.T.J.Bailey (1975): The Mathematical Theory of Infectious Diseases and its Application, 2nd edn. London, Griffin .
5. J.D.Murray (1990): Mathematical Biology, Springer and Verlag.

Course Title: Operation Research-II
Course No: APPMAT-405

Sequencing

Sequencing problems, Solution of sequencing problems, Processing n jobs through two machines, Processing n jobs through three machines, Processing of two jobs through m machines, Processing n jobs through m machines.

Project Scheduling and Network: PERT and CPM

Introduction, Basic difference between PERT and CPM, Steps of PERT and CPM Techniques, PERT and CPM Network components and precedence relationship. Project scheduling by PERT and CPM, Construction of a network, Fulkerson's i - j rule, Errors and dummies in Network, Critical path analysis, Shortest route model, Forward and backward pass methods, Floats of an activity, Project costs by CPM, Crashing of an activity, Crash-cost slope, Project Time-cost,Trade off.Solution of network problems using Simplex technique.Probability of completion of a project within a scheduled time.

Replacement and Maintenance Models

Introduction, Replacement problem, Types of replacement problems, Replacement of capital equipment that varies with time, Replacement policy for items where maintenance cost increases with time and money value is not considered, Replacement policy for item whose maintenance cost increases with time and money value changes at a constant rate, Group replacement policy, Individual replacement policy, Mortality theorem, Replacement and promotional problems.

Inventory Control

Introduction, Inventory control-Deterministic including price breaks and Multi-item with constraints, Inventory control-Probabilistic (with and without lead time). Fuzzy and Dynamic inventory models.

References:

1. Operations Research - S.D.Sharma
2. Operations Research - Kanti Swarup, P.K. Gupta andManmohan
3. OR methods and Problems - Sasieni Maurice, Arther Yaspan, LawrenceFriedman
4. Operations Research - H.S. Taha
5. Introduction to Operations Research,McGraw-Hill,1995, F.S.Hiller & G.C.Leiberman.
6. Nonlinear and Dynamic Programming, AddisonWesley, G.Hadly.
7. Operations Research: Theory and Applications, McMillan,2013, K. Sharma,
8. Operations Resarch - T.L.Satty.

Course Title: Mathematical Elasticity-II
Course No: APPMAT-406

Solution by means of functions of a complex variable : Plane Stress and Plane Strain Problems. Solution of Plane Stress and Plane Strain Problems in Polar Co ordinates. General Solution for an infinite plate with a circular hole. An infinite Plate under the Action of Concentrated Forces and Moments.

Three dimensional problems : Beam Stretched by its own weight.Solution of differential equations of equilibrium in terms of stresses. Stress function. Reduction of Lame and Beltrami equations to biharmonic equations. Relvin and Boussinesq-Papkovich solution. Pressure on the Surface of a Semi-infiniteBody.

Theory of thin plates : Basic equations for bending of plates. Boundary conditions. Navier's and Levy solutions for rectangular plates. Circular Plate. Cylindrical Bending of Uniformly Loaded Plates.

Variational methods : Theorems of Minimum Potential Energy. Theorems of Minimum Supplementary Energy. Uniqueness of Solutions. Reciprocal theorem of Betti and Rayleigh – applications. Solution of Eulevs equation by Ritz, Galerkin and Rantorovich method.

Solution of simple crack problem using integral equations and integral transform methods- line and penny shaped crack, determination of SIF, crack propogation, Branching and arrest phenomena.

Reference:

1. A Treatise on The Mathematical Theory of Elasticity – A. E.Love
2. Mathematical Theory of Elasticity - I. S.Sokolnikoff
3. Theory of Elasticity – S. Timoshenko and J. N.Goodier
4. Elasticity Theory and Applications – A. S.Saada
5. Foundations of Solid Mechanics – Y. C.Fung
6. Theory of Elasticity – Y. A.Amenzade
7. Applied Elasticity – ZhilunXu
8. Wave Propagations in Elastic Solids – J. D.Achenbach
9. Elasto-dynamics – A. C.Eringen
10. Wave Motion in Elastic Solids – K. F.Graff
11. Applied Elastity – Chi-TheWang.

Course Title: Fluid Dynamics-II
Course No: APPMAT-407

Basic thermodynamics of one compressible fluid:
Six governing equations of fluid motion, crocco-vazsonyl equation. Propagation of small disturbances in a gas. mach number. Dynamics similarity of two flows. Circulation theorem. Permanence of irrotational motion. Bernoulli's integral for steady isentropic and irrotational motion. Polytropic gas. Critical speed. Equation satisfied velocity potential and stream functions. Prandtl-Mayer fluid past a convex corner.

Steady flow through a De Level nozzle. Normal and oblique shock wave shock polar diagram one dimensional similarity folw.

Steady linearised subsonic and supersonic flows. Prandtl-Glauert transformation. Flow along a wavy boundary flow past a slight corner. Jangen-rayleigh method of approximation. Thin supersonic wind Ackeret's formula.

Legendre and molenbroek transformations Chaplygin's equation for stream function. Solution of chaplygin's equation. Subsonic gas jet problem limiting line. Motion due to a two dimensional source and a vortex Karman-Tsien approximation. Two dimensional steady flow : Riemann invarience. Method of characteristic. Transonic flow. Law transonic similarity. Euler's-Tricomi equation and its fundamental solution. Hypersonic flow.

References:

1. Hydrodynamics –A.S.Ramsay(Bell)
2. Hydrodynamics – H. Lamb(Cambridge)
3. Fluid mechanics – L.D.Landou and E.M.Lifchiz(Pergamon),1959
4. Theoritical hydrodynamics –L.M.Thomson
5. Theoritical aerodynamics –I.M.Milne-Thomson;Macmillan, 1958
6. Introduction to the theory of compressible flow –Shih-I.Pai; Van Nostrand, 1959
7. Inviscid gas dynamics – P.Niyogi, Mcmillan, 1975(india)
8. Gas dynamics – K.Oswatitsch(english tr.) academic press, 1956