# Mahakaushal University, Jabalpur (M.P.)

## Scheme & Syllabus

**For**

**B.Sc. with Research/honors**

**Mathematics**

**2022-23**

**Duration of Course: 4 Years**

**Examination Mode: Semester**

**Examination System: CBCS**

**Mahakaushal University**
**Village-Aithakheda, Mukunwara Road, Post- Tilwara Jabalpur (M.P.) 482003**

# Credit Distribution

| SEMESTER SYSTEM | | | | | | Credits Required | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Sem** | **MJ** | **MI** | **DSE** | **GEC/ OEC** | **AECC** | **SEC SB/VB** | **FW** | **Total Credit** |
| Level 5 | Certificate | 1st Year Pass (Sem I+Sem II) | I | 6 | 6 | | 4 | 4 | | | **20** |
| | | | II | 6 | 6 | | 4 | 4 | | | **20** |
| Level 6 | Diploma | 2nd Year Pass (Sem III+Sem IV) | III | 6 | 6 | | 4 | | 4 | | **20** |
| | | | IV | 6 | 6 | | 4 | | 4 | | **20** |
| Level 7 | Degree | 3rd Year Pass (Sem V+Sem VI) | V | 6 | | 4 | | | 4 | 6 | **20** |
| | | | VI | 6 | | 8 | | | | 6 | **20** |
| Level 8 | Honors/ Research | 4th Year Pass (Sem VII+Sem VIII) | VII | 6 | 4 | 4 | | | | 6 | **20** |
| | | | VIII | 6 | 4 | | | | | 10 | **20** |
| | **Total Credit** | | | **48** | **32** | **16** | **16** | **8** | **12** | **28** | **160** |

| SEMESTER SYSTEM | | | | | Credits Required | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **MJ** | **MI** | **DSE** | **GEC/ OEC** | **AECC** | **SEC SB/VB** | **FW** | **Total Credit** |
| Level 5 | Certificate | 1st Year Pass | 12 | 12 | | 8 | 8 | | | **40** |
| Level 6 | Diploma | 2nd Year Pass | 12 | 12 | | 8 | | 8 | | **40** |
| Level 7 | Degree | 3rd Year Pass | 12 | | 12 | | | 4 | 12 | **40** |
| Level 8 | Honors/ Research | 4th Year Pass | 12 | 8 | 4 | | | | 16 | **40** |
| | **Total Credit** | | **48** | **32** | **16** | **16** | **8** | **12** | **28** | **160** |

**For Regular Students Course Duration:**

| | |
|---|---|
| Min. Years for Completing UG Degree | 3 Years |
| Min Years for Completing UG (Hons.) Degree | 4 Years |
| Maximum Years for Completing UG Degree | 6 Years |
| Max Years for Completing UG (Hons.) Degree | 8 Years |

| Faculty of Science | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Major: Mathematics** | | | | | | | | | |
| **Sem** | **Major** | **Minor** | **DSE** | **Open Elective/ Generic Elective** | **AECC** | **SEC** | | **FW** | **Total Credits** |
| | | | | | | **Skill Based** | **Value Based** | | |
| 1 | MJ-I (4+2) | MN-I (4+2) | | OEC-I (4) | AECC-I (4) | | | | **20** |
| 2 | MJ-II (5+1) | MN-II (4+2) | | OEC-II (4) | AECC-II (4) | | | | **20** |
| 3 | MJ-III (5+1) | MN-III (4+2) | | OEC-III (4) | | SECSB-I (4) | | | **20** |
| 4 | MJ-IV (4+2) | MN-IV (4+2) | | OEC-IV (4) | | SECSB-II (4) | | | **20** |
| 5 | MJ-V (5+1) | | DSE-I (4) | | | | SECVB (4) | Field Work (6) | **20** |
| 6 | MJ-VI (5+1) | | DSE-II (4) DSE-III (4) | | | | | Internship (6) | **20** |
| 7 | MJ-VII (4+2) | MN-V (4) | DSE-IV (4) | | | | | Minor Project (6) | **20** |
| 8 | MJ-VIII (4+2) | MN-VI (4) | | | | | | Major Research Project (10) | **20** |
| **Total Credits** | **48** | **32** | **16** | **16** | **8** | **8** | **4** | **28** | **160** |

## Major/Minor

| Course Code | Category | Paper | Credits |
|---|---|---|---|
| BMAT101T | MJ/MI | Calculus | 4 |
| BMAT101P | MJ/MI | Calculus Lab | 2 |
| BMAT201T | MJ/MI | Algebra | 6 |
| BMAT301T | MJ/MI | Real Analysis | 6 |
| BMAT401T | MJ/MI | Differential Equations | 4 |
| BMAT401P | MJ/MI | Differential Equations Lab | 2 |
| BMAT501T | MJ/MI | Theory of Real Functions | 6 |
| BMAT601T | MJ/MI | Group Theory | 6 |
| BMAT701T | MJ | PDE and Systems of ODE | 4 |
| BMAT701P | MJ | PDE and Systems of ODE Lab | 2 |
| BMAT801T | MJ | Numerical Methods | 4 |
| BMAT801P | MJ | Numerical Methods Lab | 2 |

## Department Specific Elective

| | | | |
|---|---|---|---|
| BMAT101D-I | DSE | Riemann Integration and Series of Functions | 4 |
| BMAT101D-II | DSE | Number Theory | 4 |
| BMAT102D-I | DSE | Ring Theory and Linear Algebra | 4 |
| BMAT102D-II | DSE | Industrial Mathematics | 4 |
| BMAT103D-I | DSE | Multivariate Calculus | 4 |
| BMAT103D-II | DSE | Boolean Algebra and Automata Theory | 4 |
| BMAT104D-I | DSE | Metric Spaces and Complex Analysis | 4 |
| BMAT104D-II | DSE | Probability and Statistics | 4 |

## Skill Enhancement Course (Skill Based) (Any Two)

| Course Code | Category | Paper | Credits |
|---|---|---|---|
| BMAT101SB | SEC-SB | Logic and Sets | 4 |
| BMAT102SB | SEC-SB | Computer Graphics | 4 |
| BMAT103SB | SEC-SB | Graph Theory | 4 |
| BMAT104SB | SEC-SB | Operating System: Linux | 4 |
| BMAT105SB | SEC-SB | Mathematical Finance | 4 |

## Open Elective Compulsory Course/ Generic Elective Compulsory Course

| Course Code | Category | Paper | Credits |
|---|---|---|---|
| OECC101-I | OEC | Fundamental of Computer | 4 |
| OECC101-II | OEC | Environmental Studies | 4 |
| OECC102-I | OEC | Entrepreneurship | 4 |
| OECC102-II | OEC | Principle of Management | 4 |
| OECC103-I | OEC | Nutrition and Fitness | 4 |
| OECC103-II | OEC | Current Concerns in Public Health Nutrition | 4 |
| OECC104-I | OEC | Travel and Tourism | 4 |
| OECC104-II | OEC | Tourism Operation Software Skills | 4 |

## Ability Enhancement Compulsory Course

| Course Code | Category | Paper | Credits |
|---|---|---|---|
| AECC101 | AECC | English Language-I | 4 |
| AECC102 | AECC | English Language-II | 4 |

## Skill Enhancement Course (Value Based) (Any One)

| Course Code | Category | Paper | Credits |
|---|---|---|---|
| SECVB101 | SEC-VB | Constitution of India | 4 |
| SECVB102 | SEC-VB | Yoga in Life | 4 |
| SECVB103 | SEC-VB | National Service Scheme (NSS) | 4 |
| SECVB104 | SEC-VB | Health & Wellness | 4 |
| SECVB105 | SEC-VB | Sports | 4 |

## Field Work

| Course Code | Category | Paper/Description | Credits |
|---|---|---|---|
| BFWF-501 | FW | Field work is the process of observing and collecting data about people, cultures, and natural environments. | 6 |
| BFWI-601 | FW | The aim of the internship provides a direction to the activities, helps to focus on a result, and to assess the result achieved. | 6 |
| BFWP-701 | FW | The objective of the minor project is to provide an opportunity for students to undertake short research training outside the classroom to solve real-world issues. | 6 |
| BFWR-801 | FW | Project objectives describe the desired outcome of a project, which is often a tangible object. It's beneficial to create objectives for your project because creating a specific goal for you helps everyone know what they're supposed to be working toward. | 10 |

## BMAT101T: Calculus

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### Unit-I

**(14 Lectures)**

ε−δ definition of the limit of a function, Continuous functions and classification of discontinuities, Differentiability, Chain rule of differentiability, Rolle's theorem, First and second mean value theorems, Taylor's theorems with Lagrange's and Cauchy's forms of remainder, Successive differentiation and Leibnitz's theorem.

### Unit-II

**(10 Lectures)**

Expansion of functions (in Taylor's and Maclaurin's series), Indeterminate forms, Partial differentiation and Euler's theorem, Jacobians.

### Unit-III

**(10 Lectures)**

Maxima and Minima (for functions of two variables), Tangents and normals (polar form only), Curvature, Envelopes and evolutes.

### Unit-IV

**(14 Lectures)**

Asymptotes, Tests for concavity and convexity, Points of inflexion, Multiple points, Tracing of curves in Cartesian and polar co-ordinates. Reduction formulae, Beta and Gamma functions.

### Unit-V

**(12 Lectures)**

Qudrature, Rectification, Volumes and surfaces of solids of revolution, Pappus theorem, Double and triple integrals, Change of order of integration, Dirichlet's and Liouville's integral formulae.

## Reference Books:


- G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
- H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), SpringerVerlag, New York, Inc., 1989.

## BMAT101P: Calculus Lab

## Practical:

1. Plotting of graphs of function $e^{ax + b}$, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b| and to illustrate the effect of a and b on the graph.
2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).
4. Obtaining surface of revolution of curves.
5. Tracing of conics in cartesian coordinates/ polar coordinates.
6. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.
7. Matrix operation (addition, multiplication, inverse, transpose).

## Reference Books:


- G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
- H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), SpringerVerlag, New York, Inc., 1989.

## BMAT201T: Algebra

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### Unit-I

**(18 Lectures)**

Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Theorems on imaginary, integral and rational roots; Polar representation of complex numbers, De Moivre's theorem for integer and rational indices and their applications. The nth roots of unity.

### Unit-II

**(12 Lectures)**

Equivalence relations, Functions, Composition of functions, Invertibility and inverse of functions, One-to-one correspondence and the cardinality of a set.

### Unit-III

**(15 Lectures)**

Well ordering principle, The division algorithm in $\mathbb{Z}$, Divisibility and the Euclidean algorithm, Fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principle of mathematical induction.

### Unit-IV

**(18 Lectures)**

Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation $Ax = b$, Solution sets of linear systems, The inverse of a matrix; Subspaces, Linear independence, Basis and dimension, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Applications to computer graphics, Eigenvalues and eigenvectors, The characteristic equation and Cayley−Hamilton theorem.

### Unit-V

**(12 Lectures)**

Homomorphism and isomorphism, Cayley's theorem, Normal subgroups, Quotient group, Fundamental theorem of homomorphism, Conjugacy relation, Class equation, Direct product.

## Reference Books:


- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
- David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007**.**
- Dickson, Leonard Eugene (2009). First Course in the Theory of Equations. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
- Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.
- Kolman, Bernard, & Hill, David R. (2001). Introductory Linear Algebra with Applications (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.
- Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). Linear Algebra and its Applications (5th ed.). Pearson Education.

## BMAT301T: Real Analysis

**L T P**
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### Unit-I

**(14 Lectures)**

Axiomatic study of real numbers, Completeness property in R, Archimedean property, Countable and uncountable sets, Neighbourhood, Interior points, Limit points, Open and closed sets, Derived sets, Dense sets, Perfect sets, Bolzano-Weierstrass theorem.

### Unit-II

**(16 Lectures)**

Sequences of real numbers, Subsequences, Bounded and monotonic sequences, Convergent sequences, Cauchy's theorems on limit, Cauchy sequence, Cauchy's general principle of convergence, Uniform convergence of sequences and series of functions, Weierstrass M-test, Abel's and Dirichlet's tests.

### Unit-III

**(18 Lectures)**

Sequential continuity, Boundeness and intermediate value properties of continuous functions, Uniform continuity, Meaning of sign of derivative, Darboux theorem. Limit and continuity of functions of two variables, Taylor's theorem for functions of two variables, Maxima and minima of functions of three variables, Lagrange's method of undetermined multipliers.

### Unit-IV

**(15 Lectures)**

Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Improper integrals and their convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, Integral as a function of a parameter and its differentiability and integrability.

### Unit-V

**(12 Lectures)**

Definition and examples of metric spaces, Neighbourhoods, Interior points, Limit points, Open and closed sets, Subspaces, Convergent and Cauchy sequences, Completeness, Cantor's intersection theorem.

## Reference Books:


- R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
- Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
- S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.
- S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
- A.Kumar, S. Kumaresan, A basic course in Real Analysis, CRC Press, 2014.
- G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.

## BMAT401T: Differential Equations

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### Unit-I

**(10 Lectures)**

Bernoulli Equation – Exact Differential Equations – Equations Reducible to Exact Equations – Equations of First order and Higher degree: Equations solvable for p, Equation solvable for x and Equations Solvable for y – Clairaut's Equation.

### Unit-II

**(14 Lectures)**

Method of Variation of Parameters – $2^{nd}$ order Differential Equations with Constant Coefficients for finding the P.I's of the form $e^{ax}$ V, where V is sin(mx) or cos(mx) and $x^n$ – Equations reducible to Linear equations with constant coefficients – Cauchy's homogeneous Linear Equations – Legendre's Linear Equations.

### Unit-III

**(12 Lectures)**

Simultaneous Equations with Constant coefficients – Total Differential Equations Simultaneous Total Differential Equations – Equations of the form dx/P = dy/Q = dz/R

### Unit-IV

**(10 Lectures)**

Transform-Inverse Transform – Properties – Application of Laplace Transform to solution of first and second order Linear Differential equations [with constant coefficients].

### Unit-V

**(14 Lectures)**

Formation of PDF – Complete Integral – Particular Integral – Singular Integral – equations Solvable by direct Integration – Linear Equations of the first order – Non-linear Equations of the first Order:

Types:

f[p,q]=0,

f[x,p,q]=0, f[y, p, q]=0, f(z, p, q]=0, f[x, q]= f[y, p],

z= px+qy + f[p, q]

## Reference Books:


- S.Narayananand T.K.Manickavachagapillai[2004] Calculus S.Viswanathan Printers and publishers Pvt.Ltd.,Cheenai.
- M.D. Raisinghania, [2001] Ordinary and Partial Differential Equations, S.Chand and Co., New Delhi.
- M.R.Spiegel [2005] Advanced mathematics for Engineers and Scientists, Tata McGraw Hill Edition, New Delhi.
- M.R.Spiegel [2005] Laplace Transforms, Tata McGraw Hill Edition, New Delhi.
- S.Sudha [2003] Differential Equations and Integral Transforms, Emerald Publishers, Chennai.
- M.K.Venkataraman [1998] Higher Engineering Mathematics, III-B, National Publishing Co., Chennai.
- P.r.Vittal [2004] Differential Equations and Laplace Transform, Margham Publications, Chennai.
- P.Kandasamy, K.Thilagarathy [2004] Mathematics for B.Sc. Vol. III S.Chand& Co., Ltd., New Delhi-55.
- B.S.Grewal [2002] Higher Engineering Mathematics, Khanna Publishers, New Delhi.
- Sheply. L.Ross [1984] Differential Equations, III Edition john Wiley and Sons, New York.

## BMAT401P: Differential Equations Lab

## Practical:

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
10. Battle model (basic battle model, jungle warfare, long range weapons).
11. Plotting of recursive sequences.
12. Study the convergence of sequences through plotting.
13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
15. Cauchy's root test by plotting nth roots.
16. Ratio test by plotting the ratio of nth and (n+1)th term.

## Reference Books:


- Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York, 2009.
- C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
- S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

## BMAT501T: Theory of Real Functions

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### Unit-I

**(12 Lectures)**

Limits of functions (ε − δ approach), sequential criterion for limits. Algebra of limits for functions, effect of limit on inequality involving functions, one sided limits. Infinite limits and limits at infinity. Important limits like $\frac{\sin x}{x}, \frac{\log(1+x)}{x}, \frac{a^x-1}{x}$ $(a > 0)$ $as$ $x \to 0$

### Unit-II

**(16 Lectures)**

Continuity of a function on an interval and at an isolated point. Sequential criteria for continuity. Concept of oscillation of a function at a point. A function is continuous at x if and only if its oscillation at x is zero. Familiarity with the figures of some well known functions : $y = x^a$ (a = 2, 3, 1/2 , −1), |x|, sin x, cos x, tan x, log x, $e^x$ . Algebra of continuous functions as a consequence of algebra of limits. Continuity of composite functions. Examples of continuous functions. Continuity of a function at a point does not necessarily imply the continuity in some neighbourhood of that point.

### Unit-III

**(18 Lectures)**

Bounded functions. Neighbourhood properties of continuous functions regarding boundedness and maintenance of same sign. Continuous function on [a, b] is bounded and attains its bounds. Intermediate value theorem.

Discontinuity of functions, type of discontinuity. Step functions. Piecewise continuity. Monotone functions. Monotone functions can have only jump discontinuity. Monotone functions can have atmost countably many points of discontinuity. Monotone bijective function from an interval to an interval is continuous and its inverse is also continuous.

Uniform continuity. Functions continuous on a closed and bounded interval is uniformly continuous. A necessary and sufficient condition under which a continuous function on a bounded open interval I will be uniformly continuous on I. A sufficient condition under which a continuous function on an unbounded open interval I will be uniformly continuous on I (statement only). Lipschitz condition and uniform continuity.

## Unit-IV

**(16 Lectures)**

Differentiability of a function at a point and in an interval, algebra of differentiable functions. Meaning of sign of derivative. Chain rule.

Darboux theorem, Rolle's theorem, Mean value theorems of Lagrange and Cauchy — as an application of Rolle's theorem. Taylor's theorem on closed and bounded interval with Lagrange's and Cauchy's form of remainder deduced from Lagrange's and Cauchy's mean value theorem respectively. Expansion of $e^x$ , $\log(1 + x)$, $(1 + x)^m$, $\sin x$, $\cos x$ with their range of validity (assuming relevant theorems). Application of Taylor's theorem to inequalities.

## Unit-V

**(13 Lectures)**

Statement of L' Hospital's rule and its consequences. Point of local extremum (maximum, minimum) of a function in an interval. Sufficient condition for the existence of a local maximum/minimum of a function at a point (statement only). Determination of local extremum using first order derivative. Application of the principle of maximum/minimum in geometrical problems.

## Reference Books:


- R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
- Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis,Prentice Hall, 2001.
- S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
- T. Apostol, Mathematical Analysis, Narosa Publishing House
- Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
- C. C. Pugh, Real Mathematical Analysis, Springer, 2002.
- Terence Tao, Analysis I, Hindustan Book Agency, 2006.
- S. Goldberg, Calculus and mathematical analysis.
- Horst R. Beyer, Calculus and Analysis, Wiley, 2010.

## BMAT601T: Group Theory

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### Unit-I

**(14 Lectures)**

Symmetries of a square, Dihedral groups, Definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), Elementary properties of groups.

### Unit-II

**(12 Lectures)**

Subgroups and examples of subgroups, Centralizer, Normalizer, Center of a group, Product of two subgroups; Properties of cyclic groups, Classification of subgroups of cyclic groups.

### Unit-III

**(18 Lectures)**

Cycle notation for permutations, Properties of permutations, Even and odd permutations, Alternating groups; Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem; Normal subgroups, Factor groups, Cauchy's theorem for finite abelian groups.

### Unit-IV

**(15 Lectures)**

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Cayley's theorem, Properties of isomorphisms, First, Second and Third isomorphism theorems for groups.

### Unit-V

**(16 Lectures)**

Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups.

## Reference Books:


- Dummit, David S., & Foote, Richard M. (2016). Abstract Algebra (3rd ed.). Student Edition. Wiley India.
- Gallian, Joseph. A. (2013). Contemporary Abstract Algebra (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
- Rotman, Joseph J. (1995). An Introduction to The Theory of Groups (4th ed.). Springer-Verlag, New York.
- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
- Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
- I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

## BMAT701T: PDE and Systems of ODE

| L | T | P |
|---|---|---|
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### Unit-I

**(12 Lectures)**

Introduction, Classification, Construction and geometrical interpretation of first order partial differential equations (PDE), Method of characteristic and general solution of first order PDE, Canonical form of first order PDE, Method of separation of variables for first order PDE.

### Unit-II

**(10 Lectures)**

Gravitational potential, Conservation laws and Burger's equations, Classification of second order PDE, Reduction to canonical forms, Equations with constant coefficients, General solution.

### Unit-III

**(12 Lectures)**

Mathematical modeling of vibrating string and vibrating membrane, Cauchy problem for second order PDE, Homogeneous wave equation, Initial boundary value problems, Nonhomogeneous boundary conditions, Finite strings with fixed ends, Non-homogeneous wave equation, Goursat problem.

### Unit-IV

**(14 Lectures)**

Method of separation of variables for second order PDE, Vibrating string problem, Existence and uniqueness of solution of vibrating string problem, Heat conduction problem, Existence and uniqueness of solution of heat conduction problem, Non-homogeneous problem.

### Unit-V

**(12 Lectures)**

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two

unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method.

## Reference Books:


- Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
- S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
- Myint-U, Tyn & Debnath, Lokenath. (2007). Linear Partial Differential Equation for Scientists and Engineers (4th ed.). Springer, Third Indian Reprint, 2013.
- Sneddon, I. N. (2006). Elements of Partial Differential Equations, Dover Publications. Indian Reprint.
- Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). Partial Differential Equations: An Introduction with Mathematica and MAPLE (2nd ed.). World Scientific.

## BMAT701P: PDE and Systems of ODE Lab

## Practical:

1. Solution of Cauchy problem for first order PDE.
2. Finding the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions
   a) $u(x,0) = \Phi(x), u_t(x,0) = \psi(x), x \in \mathrm{R}, \mathrm{t} > 0$
   b) $u(x,0) = \Phi(x), u_t(x,0) = \psi(x), u(0,t) = 0, x \in (0,\infty), \mathrm{t} > 0$
   c) $u(x,0) = \Phi(x), u_t(x,0) = \psi(x), u_x(0,t) = 0, x \in (0,\infty), \mathrm{t} > 0$
   d) $u(x,0) = \Phi(x), u_t(x,0) = \psi(x), u(0,t) = 0, u(1,t) = 0, 0 < x < l,\ \mathrm{t} > 0$
5. Solution of wave equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:
   a) $u(x,0) = \Phi(x), u(0,t) = \mathrm{a},\ \mathrm{u}(l,t) = b,\ 0 < x < l,\ \mathrm{t} > 0$
   b) $u(x,0) = \Phi(x), x \in \mathrm{R},\ 0 < t < T$
   c) $u(x,0) = \Phi(x), u(0,t) = a, x \in (0,\infty), \mathrm{t} \geq 0$

## Reference Books:


- Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
- S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
- Myint-U, Tyn & Debnath, Lokenath. (2007). Linear Partial Differential Equation for Scientists and Engineers (4th ed.). Springer, Third Indian Reprint, 2013.
- Sneddon, I. N. (2006). Elements of Partial Differential Equations, Dover Publications. Indian Reprint.
- Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). Partial Differential Equations: An Introduction with Mathematica and MAPLE (2nd ed.). World Scientific.

## BMAT801T: Numerical Methods

| L | T | P |
|---|---|---|
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### Unit-I

**(18 Lectures)**

Representation of real numbers, Machine Numbers - floating point and fixed point. Sources of Errors, Rounding of numbers, significant digits and Error Propagation in machine arithmetic operations. Numerical Algorithms - stability and convergence.

Approximation: Classes of approximating functions, Types of approximations- polynomial approximation, The Weierstrass polynomial approximation theorem (statement only).

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton (Gregory) forward and backward difference interpolation.

Central Interpolation: Stirling's and Bessel's formulas. Different interpolation zones, Error estimation. Hermite interpolation.

### Unit-II

**(12 Lectures)**

Numerical differentiation: Methods based on interpolations, methods based on finite differences.

Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Weddle's rule, Boole's Rule, midpoint rule. Composite trapezoidal rule, composite Simpson's 1/3rd rule, composite Weddle's rule. Gaussian quadrature formula.

### Unit-III

**(14 Lectures)**

Transcendental and polynomial equations: Bisection method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Condition of convergence (if any), Order of convergence, Rate of convergence of these methods. Modified Newton-Raphson method for multiple roots, Complex roots of an algebraic equation by Newton-Raphson method. Numerical solution of system of nonlinear equations - Newton's method.

## Unit-IV

**(8 Lectures)**

System of linear algebraic equations: Direct methods: Gaussian elimination and Gauss Jordan methods, Pivoting strategies.

Iterative methods: Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition method (Crout's LU decomposition method).

Matrix inversion: Gaussian elimination and LU decomposition method (Crout's LU decomposition method) (operational counts).

The algebraic eigen value problem: Power method.

## Unit-V

**(8 Lectures)**

Ordinary differential equations: Single-step difference equation methods- error, convergence. The method of successive approximations (Picard), Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

## Reference Books:


- Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India.
- M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering
- Computation, 6th Ed., New age International Publisher, India, 2007.
- C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
- Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
- John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
- Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
- Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
- Yashavant Kanetkar, Let Us C, BPB Publications.

## BMAT801P: Numerical Methods Lab

## Practical:

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. To find the absolute value of an integer.
3. Enter 100 integers into an array and sort them in an ascending order.
4. Bisection Method.
5. Newton Raphson Method.
6. Secant Method.
7. Regulai Falsi Method.
8. LU decomposition Method.
9. Gauss-Jacobi Method.
10. SOR Method or Gauss-Siedel Method.
11. Lagrange Interpolation or Newton Interpolation.
12. Simpson's rule.

## Reference Books:


- Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India.
- M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering
- Computation, 6th Ed., New age International Publisher, India, 2007.
- C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
- Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
- John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
- Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
- Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
- Yashavant Kanetkar, Let Us C, BPB Publications.

# Department Specific Elective

## BMAT101D-I: Riemann Integration and Series of Functions

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### Unit-I

**(10 Lectures)**

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability.

### Unit-II

**(14 Lectures)**

Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus..

### Unit-III

**(10 Lectures)**

Improper integrals; Convergence of Beta and Gamma functions.

### Unit-IV

**(12 Lectures)**

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

### Unit-V

**(14 Lectures)**

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

## Reference Books:


- K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

## BMAT101D-II: Number Theory

**L T P**
**4 0 0**

### Unit-I

**(12 Lectures)**

Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

### Unit-II

**(12 Lectures)**

Number theoretic functions for sum and number of divisors, Multiplicative function, Möbius inversion formula, Greatest integer function. Euler's phi-function and properties, Euler's theorem.

### Unit-III

**(12 Lectures)**

The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, and Euler's criterion.

### Unit-IV

**(12 Lectures)**

The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli; Public key encryption, RSA encryption and decryption.

### Unit-V

**(12 Lectures)**

Affine ciphers, Hill ciphers, publickey cryptography, RSA encryption and decryption, the equation $x^2+y^2=z^2$, Fermat's Last Theorem.

## Reference Books:


- David M.Burton, Elementary Number Theory (6thEdition), TataMcGraw-Hill Edition, Indian reprint, 2007.
- Thomas Koshy, ElementaryNumber Theory with Applications (2nd Edition), Academic Press, 2007.
- Neville Robinns, Beginning Number Theory (2ndEdition), Narosa Publishing House Pvt.Limited, Delhi,2007.
- Burton, David M. (2012). Elementary number Theory (7th ed.). Mc-Graw Hill Education Pvt. Ltd. Indian Reprint.
- Jones, G. A., & Jones, J. Mary. (2005). Elementary nmber Theory. Undergraduate Mathematics Series (SUMS). First Indian Print.
- Neville Robinns. (2007). Beginning number Theory (2nd ed.). Narosa Publishing House Pvt. Limited, Delhi.

## BMAT102D-I: Ring Theory and Linear Algebra

| L | T | P |
|---|---|---|
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### Unit-I

**(16 Lectures)**

Definition and examples of rings, Properties of rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideals, Ideal generated by a subset of a ring, Factor rings, Operations on ideals, Prime and maximal ideals.

### Unit-II

**(10 Lectures)**

Ring homomorphisms, Properties of ring homomorphisms, First, Second and Third Isomorphism theorems for rings, The Field of quotients.

### Unit-III

**(10 Lectures)**

Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces, Linear combination of vectors, Linear span, Linear independence, Basis and dimension, Dimension of subspaces.

### Unit-IV

**(14 Lectures)**

Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations, Isomorphisms, Isomorphism theorems, Invertibility and the change of coordinate matrix.

### Unit-V

**(10 Lectures)**

Divisibility in integral domains, irreducible, primes, unique factorization domains, Euclidean domains.

## Reference Books:


- Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi.
- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
- S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
- Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
- S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
- Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
- D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

## BMAT102D-II: Industrial Mathematics

**L T P**
**4 0 0**

### Unit-I

**(10 Lectures)**

Medical Imaging and Inverse Problems. The content is based on Mathematics of X-ray and CT scan based on the knowledge of calculus, elementary differential equations, complex numbers and matrices.

### Unit-II

**(12 Lectures)**

Introduction to Inverse problems: Why should we teach Inverse Problems? Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations. Geological anomalies in Earth's interior from measurements at its surface (Inverse problems for Natural disaster) and Tomography.

### Unit-III

**(10 Lectures)**

X-ray: Introduction, X-ray behavior and Beers Law (The fundament question of image construction) Lines in the place.

### Unit-IV

**(14 Lectures)**

Radon Transform: Definition and Examples, Linearity, Phantom (Shepp - Logan Phantom - Mathematical phantoms).

Back Projection: Definition, properties and examples.

### Unit-V

**(14 Lectures)**

CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan..

## Reference Books:


- Timothy G. Feeman, The Mathematics of Medical Imaging, A Beginners Guide, Springer Under graduate Text in Mathematics and Technology, Springer, 2010.
- C.W. Groetsch, Inverse Problems, Activities for Undergraduates, The Mathematical Association of America, 1999.
- Andreas Kirsch, An Introduction to the Mathematical Theory of Inverse Problems, 2nd Ed., Springer, 2011.

## BMAT103D-I: Multivariate Calculus

**L T P**
**4 0 0**

### Unit-I

**(14 Lectures)**

Functions of several variables, limit and continuity of functions of two variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

### Unit-II

**(14 Lectures)**

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems. Definition of vector field, divergence and curl, Double integration over rectangular region, double integration over nonrectangular region. Double integrals in polar co-ordinates.

### Unit-III

**(12 Lectures)**

Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co- ordinates. Change of variables in double integrals and triple integrals.

### Unit-IV

**(12 Lectures)**

Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stokes' theorem, The Divergence theorem.

### Unit-V

**(8 Lectures)**

Concept of neighbourhood of a point in $R^n$ ($n > 1$), interior point, limit point, open set and closed set in $R^n$ ($n > 1$).

## Reference Books:


- G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
- E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
- James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

## BMAT103D-II: Boolean Algebra and Automata Theory

**L T P**
**4 0 0**

### Unit-I

**(12 Lectures)**

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

### Unit-II

**(12 Lectures)**

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

### Unit-III

**(12 Lectures)**

Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

### Unit-IV

**(12 Lectures)**

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

### Unit-V

**(12 Lectures)**

Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence. Undecidability: Recursively

enumerable and recursive languages, undecidable problems about Turing machines: halting problem, Post Correspondence Problem, and undecidability problems About CFGs.

## Reference Books:


- B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
- Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages, and Computation, 2nd Ed., Addison-Wesley, 2001.
- H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, Elements of the Theory of Computation, 2nd Ed., Prentice-Hall, NJ, 1997.
- J.A. Anderson, Automata Theory with Modern Applications, Cambridge University Press, 2006.

## BMAT104D-I: Metric Spaces and Complex Analysis

**L T P**
**4 0 0**

### Unit-I

**(14 Lectures)**

Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separable spaces.

### Unit-II

**(8 Lectures)**

Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem. Connectedness, connected subsets of R.

### Unit-III

**(8 Lectures)**

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

### Unit-IV

**(16 Lectures)**

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. CauchyGoursat theorem, Cauchy integral formula.

### Unit-V

**(14 Lectures)**

Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.

## Reference Books:


- Satish Shirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
- S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
- G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
- James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
- Joseph Bak and Donald J. Newman, Complex Analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

## BMAT104D-II: Probability and Statistics

**L T P**
**4 0 0**

### Unit-I

**(8 Lectures)**

Probablity: Introduction, Sample spaces, Events, probability of events, rules of probability, conditional probability, independent events, Bayes's theorem.

### Unit-II

**(16 Lectures)**

Probability distributions and probability densities: random variables, probability distributions, continuous random variables, probability density functions, Multivariate distributions, joint distribution function, joint probability density function, marginal distributions, conditional distributions, conditional density, The theory in practice, data analysis, frequency distribution, class limits, class frequencies, class boundary, class interval, class mark, skewed data, multimodality, graphical representation of the data, measures of location and variability. Population, sample, parameters.

### Unit-III

**(10 Lectures)**

Mathematical Expectation:Introduction, expected value of random variable, moments, Chebyshev's theorem, moment generating functions, product moments, moments of linear combinations of random variables, conditional expectations, the theory in practice, measures of location, dispersion.

### Unit-IV

**(16 Lectures)**

Special probability distributions: Discrete Uniform distribution, binomial distribution, Negative binomial, geometric, hypergeometric, poisson, multinomial distribution, multinomial. Special probability densities; Uniform distribution, gamma, exponential, gamma, chi-square, beta distribution, normal, normal approximation to binomial, bivariate normal, Functions of random variables, distribution function technique, transformation technique-one variable, several variables, moment generating function technique.

### Unit-V

**(10 Lectures)**

Sampling distributions: population distribution, random sample, sampling distribution of mean, Central Limit theorem, Sampling distribution of the mean: finite populations, chi-square, t, F distributions, regression and correlation: Bivariate regression, regression equation, Linear regression, method of least squares.

## Reference Books:


- Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
- Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Application, 7th Ed., Pearson Education, Asia, 2006.
- Sheldon Ross, Introduction to Probability Model, 9th Ed., Academic Press, Indian Reprint, 2007.
- Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007

# Skill Based: Skill Enhancement Courses

## BMAT101SB: Logic and Sets

| L | T | P |
|---|---|---|
| 4 | 0 | 0 |

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, nary relations.

## Reference Books:


- R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
- P.R. Halmos, Naive Set Theory, Springer, 1974.
- E. Kamke, Theory of Sets, Dover Publishers, 1950.

## BMAT102SB: Computer Graphics

| L | T | P |
|---|---|---|
| 4 | 0 | 0 |

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices. Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti aliasing. Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

## Reference Books:


- D. Hearn and M.P. Baker, Computer Graphics, 2nd Ed., Prentice–Hall of India, 2004.
- J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, Computer Graphics: Principals and Practices, 2nd Ed., Addison-Wesley, MA, 1990.
- D.F. Rogers, Procedural Elements in Computer Graphics, 2nd Ed., McGraw Hill Book Company, 2001.
- D.F. Rogers and A.J. Admas, Mathematical Elements in Computer Graphics, 2nd Ed., McGraw Hill Book Company, 1990.

## BMAT103SB: Graph Theory

| L | T | P |
|---|---|---|
| 4 | 0 | 0 |

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

## Reference Books:


- B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
- Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

## BMAT104SB: Operating System: Linux

**L T P**
**4 0 0**

Linux – The Operating System: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, Overview of Linux architecture, Installation, Start up scripts, system processes (an overview), Linux Security, The Ext2 and Ext3 File systems: General Characteristics of, The Ext3 File system, file permissions. User Management: Types of users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools. Resource Management in Linux: file and directory management, system calls for files Process Management, Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls for processes, Memory Management, library and system calls for memory.

## Reference Books:


- Arnold Robbins, Linux Programming by Examples The Fundamentals, 2nd Ed., Pearson Education, 2008.
- Cox K, Red Hat Linux Administrator's Guide, PHI, 2009.
- R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.
- Sumitabha Das, Unix Concepts and Applications, 4th Ed., TMH, 2009.
- Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, 6th Ed., O'Reilly Media, 2009.
- Neil Matthew, Richard Stones, Alan Cox, Beginning Linux Programming, 3rd Ed., 2004.

## BMAT105SB: Mathematical Finance

| L | T | P |
|---|---|---|
| 4 | 0 | 0 |

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds. Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

## Reference Books:


- David G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998.
- John C. Hull, Options, Futures and Other Derivatives, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
- Sheldon Ross, An Elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA, 2003.