JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)
"A" Road, Churchgate, Mumbai - 400 020, India.

Affiliated to
University of Mumbai

Program : B.Sc.

Proposed Subject: Mathematics

Semester VI

Credit Based Semester and Grading System (CBGS) with effect from the academic year 2020-21

T.Y.B.Sc. Mathematics Syllabus

Academic year 2020-2021

Semester VI			
Course Code	**Course Title**	**Credits**	**Lectures /Week**
SMAT601	Real and Complex Analysis	4	3
SMAT602	Abstract Algebra-II	4	3
SMAT603	Metric Spaces-II	4	3
SMAT604	Data Analytics - II	4	3
SMAT6PR1	Practical I (Based on SMAT601 and 602)	4	6
SMAT6PR2	Practical II (Based on SMAT603 and 604)	4	6

Semester VI – Theory

Course: SMAT601	**Real and Complex Analysis (No. of Credit: 4 , No. of Lectures / week : 3)**	
Course Objectives This Course starts with sequence and series of function. Further in this paper concepts of differentiation and integration are extended on complex field. This course has a wide variety of application in physics and engineering. The main objective of the course is to make students competent in solving real world mathematical problem. **Course Outcome** This course can help students to pursue research in applied Mathematics		
Unit I	**Sequence and series of functions** **(a)** Point wise and uniform convergence of sequences of functions, consequences of uniform convergence **(b)** Convergence and uniform convergence of series of functions, integration and differentiation of series of functions.	**15 L**
Unit II	**Introduction to Complex Analysis** **(a)** Review of complex numbers: Complex plane, polar coordinates, exponential map, powers and roots of complex numbers, De Moivre's formula. **(b)** Continuous functions f: C→ C, real and imaginary parts. Derivative of f: C → C, comparison between differentiability in real and complex sense. **(c)** Cauchy-Riemann equations, sufficient conditions for differentiability, analytic functions. Harmonic Conjugate.	**15 L**
Unit III	**Complex power series** **(a)** Line integral f(z) over $\|z - z_0\| = r$. The Cauchy integral formula. Taylor's theorem for analytic function. **(b)** Mobius transformation, Power series of complex number, uniqueness of series representation, examples. **(c)** Isolated singularity and definition of Laurent series, Type of isolated singularities defined using Laurent series expansion **(d)** Statement of residue theorem and calculation of residue.	**15 L**

Reference

- R.R. Goldberg, Methods of Real Analysis, Oxford and International Book House (IBH) Publishers, New Delhi.
- Ajit Kumar, S. Kumaresan, Introduction to Real Analysis.
- J. W. Brown and R. V. Churchill, Complex variables and applications
- J. W. Brown and R.V. Churchill, Complex analysis and Applications

Additional References:

- Robert E. Greene and Steven G. Krantz, Function theory of one complex variable.
- T. W. Gamelin, Complex Analysis,

<table>
<tr><td>Course:
SMAT602</td><td colspan="2">Abstract Algebra-II (Credits : 04 Lectures/Week: 03)</td></tr>
<tr><td colspan="3">Objectives:

Ring theory is an extension of group theory and have many applications in wide areas of mathematics, cryptography, coding theory, computer science and mathematical/theoretical physics.

Outcomes:
Students will know the fundamental concepts in ring theory such as ideals, quotient rings, integral domains, fields, polynomial rings.
They will be able to extend the results from group theory to study the properties of rings and fields.</td></tr>
<tr><td>Unit I</td><td>Ring Theory
Definition and examples, zero divisors, units and basic properties.
Commutative rings , subrings, integral domains, fields with examples. Every field is an integral domain. Every finite integral domain is a field.
Characteristic of a ring, an integral domain and a field.
Ideals and operation of ideals. Quotient rings.
Principal ideal, prime ideal, maximal ideal. Characterization of prime and maximal ideals in terms of quotient rings.</td><td>15 L</td></tr>
<tr><td>Unit II</td><td>Homomorphism and Isomorphism of Rings
Ring homomorphism, kernel and image of a ring homomorphism. Properties of ring homomorphism
Pull and Pushback of ideals. Factor theorem.
First Isomorphism theorem, Second Isomorphism theorem, Third Isomorphism theorem for rings
Correspondence theorem.
Divisibility in an integral domain. Prime and irreducible elements in an integral domain.</td><td>15 L</td></tr>
<tr><td>Unit III</td><td>Polynomial Rings and Factorization
Polynomial rings R[x] where R is an integral domain or a field with examples. Units and associates in F[x] where F is a field
Division algorithm, factor theorem in F[x].Ideals in F[x].</td><td>15 L</td></tr>
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	• Reducible and irreducible polynomials. Prime and maximal ideals. Eisenstein's criterion for irreducibility of polynomials over Z. • Definition of ED,PID,UFD with examples. Theorem to prove that ED implies PID implies UFD. Examples to show that the converse is not true.	

References:

- Contemporary abstract algebra by Joseph A. Gallian , 4th edition, Narosa
- Abstract Algebra by Dummit and Foote , Wiley India Pvt. Ltd.

Additional References:

- Basic abstract algebra by Bhattacharya, Jain, Nagpaul, 2nd edition, Cambridge University Press
- A first course in abstract algebra by J.B.Fraleigh, Narosa

Course: SMAT603	**Metric Spaces-II (Credits: 04, Lectures/Week: 03)**	
Objectives: One of the primary aims of this course is to introduce some of the most important topological concepts like continuity, compactness and connectedness in a metric space. **Outcomes:** • This course offers a detailed study of compact subsets (of a metric space) and connected spaces which occupy a central position in topology. • Also, this course provides a different perspective of real analysis and at the same time it builds a preparatory ground for a general topology course. • Applications of continuous functions are pervasive in science and engineering. Heine-Borel theorem, path connectedness spaces are widely used in applied mathematics, Physics.		
Unit I	**Continuity** **(a)** Definition of a continuous function on a metric space. Characterization of continuity at a point in terms of sequences, open sets. **(b)** Characterization in terms of inverse image of open sets and closed sets. **(c)** Algebra of continuous functions in metric spaces **(d)** Uniform continuity in a metric space, definition and examples (emphasis on $\mathbb{R}$)	**15 L**
Unit II	**Compactness** **(a)** Definition of a compact set in a metric space, its examples. **(b)** Results such as i) Continuous image of a compact set is compact, ii) compact subsets are closed, iii) a continuous function on a compact set is uniformly continuous. **(c)** Characterization of compact sets in $\mathbb{R}^n$: i) Heine-Borel property, ii) Closed and boundedness property **(d)** Sequential compactness property, Bolzano-Weierstrass property	**15 L**
Unit III	**Connectedness** **(a)** Definition of connected metric space and its examples. Connected subsets of a metric space, connected subsets of $\mathbb{R}$. **(b)** Characterization of a connected space: A metric space X is	**15 L**

	connected if and only if every continuous function from X to $\{0,1\}$ is a constant function. Continuous image of a connected set is connected. **(c)** Definition of path connected space and its examples. **(d)** Path connectedness in $\mathbb{R}^n$.	

References:

- Topology of Metric spaces, S. Kumaresan, Narosa publishing house, 2nd edition, 2011
- Metric spaces, Pawan Jain, Khalil Ahmad, Narosa publishing house, 2nd edition, 2004

Additional References:

- First Course in Metric Spaces, B. K. Tyagi, Cambridge University Press, 2nd edition,2010
- Principles of Mathematical Analysis, W. Rudin, McGraw-Hill book Company, 3rd edition, 1976
- Mathematical Analysis, T. Apostol, Narosa Publishing House, 2nd edition, 2002
- Metric Spaces, E. T. Copson, Universal book stall New Delhi, 3rd edition, 1996

Course: SMAT604	Data Analytics (Credits : 04 Lectures/Week: 3)	

Course Objectives

This course introduces students to representations, techniques, and architectures used to build applied systems and to account for intelligence from a computational point of view. Students learn applications of rule chaining, heuristic search, and other problem-solving paradigms. They also learn applications of identification trees, neural nets, genetic algorithms and other learning paradigms. The course introduces contributions of vision, language, and story-understanding systems to human-level intelligence.

Course Outcomes

- Gain familiarity with basic approaches to problem solving and inference and areas of application
- Demonstrate familiarity with basic and advanced approaches to exploiting regularity in data and areas of application
- Demonstrate familiarity with computational theories of aspects of human intelligence and the role of those theories in applications
- Gain familiarity with techniques for improving human learning and influencing human thought

Unit I	**Introduction to Artificial Intelligence** Introduction and scope, Reasoning : Goal Trees and problem solving, Goal Trees and Rule Based Expert Systems, Search: Depth- first, hill climbing, beam, Optimal branch and bound, A^*	**15 L**
Unit II	**Introduction to Neural Networks** Neurons and Neural Networks, Introduction to Artificial Neural Networks, Gradient descent, forward and Back propagation, Vanishing Gradient, Activation functions, Convolution Neural Networks, Recurrent Neural Networks	**15 L**
Unit III	**Evolutionary Computation** Introduction to Evolutionary Computation, Genetic Algorithms, Genetic Programming, Evolutionary Programming, Evolution Strategies, Differential Evolution, Cultural Algorithms. Introduction to Deep Learning.	**15 L**

References

- Computational Intelligence- An Introduction: Andries P. Engelbrecht, John Willey & Sons Publications (Second Edition) 2007.
- Artificial Intelligence: Pearson Education , Patrick Henry Winston, 2002

Additional References

- Computational Intelligence And Feature Selection: Rough And Fuzzy Approaches, Richard Jensen Qiang Shen, IEEE Press Series On Computational Intelligence, A John Wiley & Sons, Inc., Publication, 2008.
- Computational Intelligence And Pattern Analysis In Biological Informatics, (Editors). Ujjwal Maulik, Sanghamitra Bandyopadhyay, Jason T. L.Wang, John Wiley & Sons, Inc, 2010.
- Neural Networks for Applied Sciences and Engineering: From Fundamentals to Complex Pattern Recognition 1st Edition, Sandhya Samarasinghe, Auerbach Publications, 2006.
- Introduction to Evolutionary Computing (Natural Computing Series) 2nd ed, A.E. Eiben , James E Smith, Springer; 2015.
- Artificial Immune System: Applications in Computer Security, Ying Tan, Wiley- IEEE Computer Society, 2016.

Semester VI – Practical

Course: SMAT6PR1	**Practical I (Based on SMAT 601 and 602) (Credits 4 : Practical/Week:6)**

Problems base on SMAT601

1. Pointwise & Uniform convergence of sequence of function
2. Pointwise & Uniform convergence of series of function
3. Limits, continuity and derivative of function of complex variable.
4. Analytic function, Finding harmonic conjugate, Mobius transformation.
5. Cauchy integral formula, Taylor series, Power series
6. Singularities of analytic function and Laurent series expansion

Problems base on SMAT602

1. Rings, Integral domains, Fields
2. Ideals and Quotient rings
3. Homomorphism and Isomorphism of rings
4. Prime and maximal ideals
5. Reducible and Irreducible polynomials
6. ED,PID,UFD

Course: SMAT6PR2	**Practical II (Based on SMAT 603 and 604) (Credits 4 : Practical/Week:6)**

Problems base on SMAT603

1. Continuous functions on metric spaces
2. Uniform continuity
3. Compact sets in a metric space
4. Compactness in $\mathbb{R}^n$(emphasis on $\mathbb{R}, \mathbb{R}^2$)
5. Connected sets in a metric space
6. Path connectedness, convex sets

Problems base on SMAT604

1. Implement Goal Trees and Rule Based Expert Systems
2. Implement Depth- first, hill climbing, beam, Optimal branch and bound, A^* algorithms
3. Implement feed forward and backward neural network for a given data.
4. Implement Radial Basis Function neural network with gradient descent.
5. Implement evolution strategy algorithm.
6. Implement general differential evolution algorithm.

Evaluation Scheme

Evaluation scheme for Theory courses

I. Continuous Assessment (C.A.) - 40 % - 40 Marks

Sr. No.	Evaluation type	Marks
1.	**C.A.-I :** It will be conducted either using any open source learning management system or by taking a test	**20**
2.	**C.A.-II :** Assignments / Project (maximum 5 students in a group)	**20**

II. Semester End Examination (SEE) - 60 % - 60 Mark , Duration 2 Hrs

Theory Question Paper Pattern:-

All Questions are Compulsory			
Question	**Options**	**Based on**	**Marks**
1.	Any 3 out of 5	**Unit I**	**15**
2.	Any 3 out of 5	**Unit II**	**15**
3.	Any 3 out of 5	**Unit III**	**15**
4.	Any 3 out of 5	**Unit IV**	**15**

Evaluation scheme for Practical courses- 200 Marks

Each student will maintain a Journal. After every practical, student will upload his practical in the form of documents along with the screen shots of output on any LMS.

Sr. No.	Heading	Marks
1.	Journal	20
2.	Practical I (Based on SMAT601 and SMAT 602)	80
3	Practical II (Based on SMAT603 and SMAT 604)	80
4	Viva	20
Total		200