CURRICULUM FOR

"Ph.D. Coursework"

(Paper-III & IV)

w.e.f. April 2025

॥ तमसो मा ज्योतिर्गमय ॥

VISION

To provide equal opportunities for value based global education for creating an Enlightened Society

MISSION

To establish and facilitate educational institutions in the region for providing affordable value based global education to all who aspire to study and to create opportunities to educators, social workers and philanthropists to serve society

SARVAJANIK UNIVERSITY

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creating an enlightened society...

UNIVERSITY OFFICE
Dr. R. K. Desai Marg, Athwalines,
Surat-395001, Gujarat, India.
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Constituent Institute:

Shree Ramkrishna Institute of Computer Education and Applied Sciences (SRKI)

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Course Curriculum
Ph.D. Coursework for PAPER – III & IV

The proposed Course Curriculum was approved by **Board of Studies; Science** under the Faculty of Science in the meeting held on 03-04-2025 and was recommended to the **'FACULTY'** for approval.

Prof. Chaulami Desai **Chairman,** **Board of Studies- Science**	**Place of the meeting** **Sarvajanik University Office**	**Sign**

The Course Curriculum approved by the **Faculty of Science** in the meeting held on 03-04-2025 and was recommended to **'ACADEMIC COUNCIL'** for approval.

Prof. Chaulami Desai **Chairman &** **Dean, Faculty of Science**	**Place of the meeting** **Sarvajanik University Office**	**Sign**

The Course Curriculum approved by the '**Academic Council of Sarvajanik University** 'in the meeting held on 28-05-2025.

Mr. Ashish Desai **Member Secretary,** **Academic Council** **& I/c. Registrar,** **Sarvajanik University**	**Place of the meeting** **Sarvajanik University Office**	**Sign**

- ***The approved curriculum of Ph.D. Coursework PAPER – III & IV is with effect from the April 2025 and to be reviewed before April 2028***

ANNEXURE - C

SARVAJANIK UNIVERSITY
Faculty of Science

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Faculty of Science

Syllabus for Ph.D. Coursework in Biotechnology Paper-III and IV

SARVAJANIK UNIVERSITY

Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences					
Faculty	Science		**Program**	Ph.D. (Biotechnology)	
Year	1		**Version**	3.0	
Semester	1/2		**Effective From**	April, 2025	
Course Code	PSBT31101	**Course Name**	Paper III: Ph.D.Biotechnology Coursework Paper III		
Teaching Scheme				**Examination Scheme**	
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
4	4	0	0	50	50	100

SARVAJANIK UNIVERSITY

Faculty of Science

Syllabus for PhD Course Work in Biotechnology

Name of Faculty: Science	**Department:** Biotechnology
Program: Biotechnology	**Type:** Theory
Credit: 04	**Total Learning Hours:** 60

Unit I: Tools and techniques in Research **(8hrs)**

1.1. Centrifugation techniques- Principle, types & applications
1.2. Spectrophotometric techniques- Principle, types & applications
1.3. Chromatographic Techniques-Principle, types & applications
1.4. Electrophoretic techniques- Principle, types & applications
1.5. Microscopy- Principle, types & applications
1.6. Types of PCR and applications
1.7 RFLP, RAPD, AFLP, Microarray

Unit 2: Recombinant DNA technology **(8hrs)**

2.1. Restriction enzymes and types; Modifying enzymes- Methylases, Polymerases, Ligases, Kinases, Phosphatases, Nucleases
2.2. Vectors for cloning, expression and library preparation (Lambda phage vectors, Cosmids, BAC, YAC)
3. Strategies for construction of genomic (Chromosome walking and jumping for positional cloning of genes) and cDNA libraries (Subtractive and Normalized libraries)
2.4. Selection of recombinant clones - Insertion Inactivation, Alpha-Complementation, Southern, Northern, Western blotting
2.5. Protein expression and purification - expression vectors; Recombinant protein expression in bacteria, yeast, plant cells & mammalian cells; Post-translational modification of proteins

Unit 3: Bioinformatics **(6 hrs)**

3.1. Introduction to Bioinformatics, Application of Bioinformatics, Role of internet, Forms of biological information
3.2. Bioinformatics Database: Sequence databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: UniProt (SCOP, CATH): Swiss-Prot, HapMap; RAP-db databases, Plant genome data bases
3.3 Sequence alignment: Pairwise sequence alignment: Basic concepts of sequence alignment, Dot plots, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, BLAST and FASTA algorithms, Multiple sequence alignment and Phylogenetic analysis Tree construction methods (NJ and ML)
3.5. Genomics: Gene annotation in prokaryotes and eukaryotes, Proteomics- Protein identification, structural classification, structure prediction.
3.6 Drug Designing

Unit 4: Immuno technology **(9 hrs)**

4.1 Components of immune system (Types of immune system; Cells tissues and organs of the immune system, cytokines, chemical mediators)
4.2 Innate immunity (Inflammation, Phagocytosis, Physiological barrier, complement system)
4.3 Adaptive immunity (T cell and B cell biology)
4.4 Structure and functions of antibodies
4.5 Expression and regulation of antibody genes
4.6 Transplantation immunology
4.7 Vaccines

Unit 5: Plant cell and tissue culture & its applications **(8 hrs)**

5.1 Tissue Culture and its types, Organogenesis and Micropropagation
5.2 In-vitro Somatic embryogenesis, synthetic seed preparation, Cryopreservation & Germplasm conservation
5.3 Plant transformation: Agrobacterium mediated, Particle bombardment, Electroporation, PEG mediated transformation
5.4 Production of haploid plant: Anther culture and Ovary Culture, Double Haploids
5.5 Somatic hybridization (Symmetric, Asymmetric, Cybrids), Dormancy and methods of breaking seed dormancy

Unit 6: Animal cell culture & its application **(8 hrs)**

6.1 Advantages, Disadvantages & Applications of ACC
6.2 Types of Tissue Culture
6.3 Initiation of Primary Culture & isolation of tissue
6.4 Types of Cell lines & parameters of characterization of cell lines.
6.5 Cell Viability (cell counting, dye inclusion & exclusion method)
6.6 Cell Separation techniques (FACS, flow cytometry, Antibody based techniques)

Unit-7 Bioprocess Technology **(7 hrs)**

7.1 Aerobic and Anaerobic fermentation processes, Optimization of Media
7.2 Different reactors (air lift, batch, continuous, fed batch condition) & Mass Transfer
7.3 Production of enzymes in submerged and solid state processes
7.4 Extraction and purification of enzymes, Immobilization
7.5 Downstream process-steps in development of a complete bioprocess for commercial manufacture of products
7.6 Mass Transfer & Flicks law

Unit-8 Environment Biotechnology **(6 hrs)**

8.1 Introduction and Scope
8.2 Types and Applications of Bioremediation
8.3 Principle and Types of Biosensor
8.4 Bioleaching
8.5 Microbial Fuel Cell

Reference books:

1.Principles of Fermentation Technology by Peter F Stanbury (Author), Allan Whitaker , Stephen J Hall ISBN: 9780080999531
2. James, B. & Ollis David, F. (2010). Biochemical engineering fundamentals. Tata Mc Graw Hill. ISBN: 9780070701236, 0070701237
3. Principles of Gene Manipulation and Genomics, 7th Edition Sandy B. Primrose, Richard Twyman ISBN: 978-1-405-13544-3
4.Gene cloning & DNA Analysis, 6th Edition, T.A. Brown, ISBN: 978-1405181730
5. Principles and Techniques of Biochemistry and Molecular Biology by Wilson/Walker ISBN: 9781316677056
6. Environmental Biotechnology, Special Indian Edition, M. H. Fulekar, Science Publishers. ISBN: 9781578085828
7.Environmental Biotechnology - Basic Concepts and Applications, 2nd edition, Indu Shekhar Thakur, I.K.International Publishing House Pvt. Ltd., ISBN: 9789380575477.
8. Introduction to Environmental Biotechnology, 3rd edition, A. K. Chatterji, PHI Learning Pvt. Ltd. ISBN: 9788120342989.
9.Janis Kuby, Kindst, Gatsby And Osborne, Kuby Immunology –, 6th Edition, W. H. Freeman Publications. ISBN-13-978-0716767640
10. John P. Harley, Donald A. Klein, Microbiology- Lansing Prescott,, 10th Edition, Mcgraw Hill Publication. ISBN-13-978-1259281594
11. A. K Abbas, A. Lichtman, S. Pillai, Cellular and Molecular Immunology-, International Edition, ISBN: 978-1-4160-3122-2 International Edition ISBN: 978-0-8089-2358-
12. Bhojwani SS. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier.
13. Buchanan B, Gruissen W & Jones R. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, USA.
14.Lewin B. 2008. *Gene IX.* Peterson Publications/ Panima.
15. Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publ.
16. Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.
17. Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene.* 6th Ed. Pearson Education.
18. In vitro Cultivation of Animal Cells by Currell B C, Butterworth- Heinemann
19.Animal Cell Culture & Technology by M Butler, Taylor & Francis Pub.
20. Animal Cell Culture by John R W. Master, oxford University Press
21. Ian R. Freshney, Culture of animal cells: a manual of basic technique and specialized applications, 6th Ed., Willey Blackwell pub.

SARVAJANIK UNIVERSITY

Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Biotechnology)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSBT31102	**Course Name**	Paper IV: Ph.D.Biotechnology Coursework Paper IV	

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
2	0	2	0	50	50	100

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Faculty of Science

Syllabus for Ph.D. Coursework in Chemistry Paper-III and IV

SARVAJANIK UNIVERSITY

Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Chemistry)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSCH31101	**Course Name**	Paper III: Ph.D. Chemistry Coursework Paper III	

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
4	4	0	0	50	50	100

SARVAJANIK UNIVERSITY
Faculty of Science

Ph.D. Chemistry Course work

Name of faculty: Science	**Department:** Chemistry
Program: Ph.D. Chemistry	**Type:** Theory
Subject: Course work – Chemistry	**Total hours: 60**
Course description: • This course gives a broader insight about the principles & applications of modern techniques used in the different area of research in chemistry like organic chemistry, inorganic chemistry, drug designing and pharma chemistry along with analytical & separation techniques.	
Student learning outcome: • Students will able to understand principles, applications & limitations of modern techniques used in chemistry research. • Students will develop rational approach in selection of techniques. • Understand, analyze and interpret results generated through use of different techniques.	

Unit I: Sampling and analytical methods **(Duration:08 Hrs)**

Location for sampling, Types of sampling, Water sample preservation, Sampling and analysis techniques of pollutants in ambient air, Soil sampling technique, Microbial methods for water analysis.

Centrifugation - Preparative and analytical, ultra-centrifugation, Density gradient centrifugation.

Chromatography – Gel filtration, Ion Exchange, Reverse phase chromatography, TLC, HPLC & UHPLC, Nano-LC.

Spectroscopy – IR, NMR, Mass Spectroscopy, AAS, X-ray crystallography.

UNIT II: Environmental process **(Duration: 08 Hrs)**

Activated Sludge Process, Anaerobic sludge digestion, Root zone technology, Microbial biosorption technology, Mass scale production of Effective Microorganisms (EM) for waste treatment, Economics of waste treatment.

Bioremediation: Introduction and Types; Bioaugmentation and Biofilteration; Bioremediation of hydrocarbons; Bioremediation of industrial wastes; Bioremediation of recalcitrant and xenobiotic compounds;

Environmental Biotechnology: Bioleaching; bioplastics; Biosensor; Microbial Fuel Cell; Down Stream process from biofermentaion process.

UNIT III: Inorganic Photochemistry **(Duration: 08 Hrs)**

Historical development of inorganic photochemistry
Fundamentals of photochemistry
Photoinduced electron transfer in inorganic molecular systems
Electron transfer processes in hetero structured photocatalysts

UNIT-IV: Modern Organic Synthesis **(Duration: 08 Hrs)**

Modern reagents in organic synthesis
Modern methods of organic synthesis
Name reactions and novel organic transformations
Target-oriented synthesis

UNIT-V: Essentials of Physical Chemistry **(Duration: 08 Hrs)**

Thermodynamics – laws and applications
Kinetics of complex and chemical reactions
Surface and colloidal chemistry
Polymer Science – polymer properties and MW determination

UNIT-VI: Analytical Chemistry **(Duration: 08 Hrs)**

Volumetric Analysis
Electrometric Analysis
Thermal Analysis
Gravimetric Analysis

UNIT-VII: Phytochemicals and Pharmacology: **(Duration: 06 Hrs)**

Introduction to phytochemistry
Common phytochemicals and chemical defense
Importance of phytochemicals in pharmacology
Applications of phytochemicals in pharmacology

UNIT-VIII: QC & QA in Laboratory **(Duration: 06 Hrs)**

Introduction to Quality assurance, quality assessment and quality control
Internal Quality Control: QC charts, Westgar multi-rules charts, Six Sigma Process, Five Q framework
Accreditation and certification: ISO, NABL, NABH Regulatory
bodies and GLP; GMP

Reference Book:

- Arceivala S. J. and Asolekar S. R (2007)Waste Water Treatment for Pollution Control and Reuse 3rd edition Mc Graw Hill Education India Pvt Ltd. (ISBN:978-0-07-0620995)
- Ghosh, Z., & Mallick, B. (2008). Bioinformatics: principles and applications. Oxford University Press. (ISBN: 0195692306)
- Glick, B. R., & Patten, C. L. (2017) Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). John Wiley & Sons. (ISBN: 1555812244).
- Jonathan Pevsner, (2009). Bioinformatics and functional genomics, Wiley–Blackwell, 2nd edition (ISBN: 0470085851).
- Khandpur R.S. (2009) Handbook of Analytical Instrument 2nd Edition Tata McGraw Hill Publishers. (*ISBN:* 9780070604605)
- Khopkar S.M. (2009) Basic Concepts of Analytical Chemistry 3rd Edition,New Age International (P) Limited, Publishers.(*ISBN:* 9781906574000)
- Martin Alexander. Biodegradation and Bioremediation 2nd Edition, Academic press. (ISBN:978-0-12-049861-1)
- Metcalf and Eddy (2003) Waste Water Engineering Treatment and Reuse. McGraw Hill Education (India) 4th edition.(ISBN:978-0-07-049539-5)
- Metcalf and Eddy (2003) Waste Water Engineering Treatment and Reuse. McGraw Hill Education (India) 4th edition. (ISBN:978-0-07-049539-5)
- Organic Synthesis: Concepts and Methods; Fuhrhop J. H., Penzlin G., and Li G., John Wiley and Sons, 2003.
- Mohapaatra P. K. (2006) Textbook of Environmental Biotechnology I.K. International Publishing House Pvt ltd. ISBN 81-88237-54-X
- Mukesh Doble and Anil Kumar (2005) Biotreatment of Industrial Effluents. Butterworth-Heinemann. (ISBN 978-0-7506-7838-4)
- Modern Methods of Organic Synthesis; W. Carruthers and I. Coldham, Cambridge University Press, 2015.
- The Logic of Chemical Synthesis; Corey E.J. and Cheng X.-M., John Wiley and Sons, 1989.
- Name Reactions and Reagents in Organic Synthesis; Mundy B. P., Ellerd M. G., Favaloro Jr. F. G., John Wiley and Sons, 2005.
- Name Reactions: A Collection of Detailed Reaction Mechanism; Li J. J., Springer Verlag, 2014.
- March's Advanced Organic Chemistry: Reactions, Mechanisms, And Structure; Smith M. B., John Wiley and Sons, 2013.
- Advanced Physical Chemistry; Gurdeep Raj, 20th Edition, 2017, Krishna Prakashan.
- Essentials of Physical Chemistry, Arun Bahl, B.S. Bahi, G.D. Tuli; 1st Revised Edition, 2008, Reprint 2016, S. Chand and Company Limited.
- Textbook of Physical Chemistry, K.K. Sharma and L.K. Sharma, 4th Edition, 2005, Vikas Publication.
- Textbook of Physical Chemistry, K.K. Sharma and L.K. Sharma, 4th Edition, 2005, Vikas Publication.
- Physical Chemistry, 10th Edition, Atkins P. W. and De Paula J., 2014, Oxford University Press
- Physical Chemistry, 4th Edition, Castellan, G. W., 2004, Narosa Publishers

- Physical Chemistry; 3rd Edition, Engel, T. & Reid, P., 2012, Prentice-Hall
- Rastogi, S. C., Rastogi, P., & Mendiratta, N. (2008). Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery 3rd Ed. PHI Learning Pvt. Ltd. (ISBN: 8120347854)
- Reece, R. J. (2004). Analysis of genes and genomes. Hoboken, NJ: John Wiley & Sons. (ISBN: 9780071077798).
- Roitt I. M., Essential Immunology, 6th Ed. ELBS, London (ISBN: 9780865427297)
- Smita Rastogi and Neelam Pathak (2009) Genetic Engineering, Oxford University Press; (ISBN: 0195696573).
- T.M.Schmidt and M.Schaechter (2012). Topics in Ecology and Environmental Microbiology Edited by Academic Press (ISBN:978-0-12-383878-0)
- Watson, J. D. (2004). Molecular biology of the gene. Pearson Education India. (ISBN: 9332585474)
- Xiong, J. (2006). Essential bioinformatics. Cambridge University Press. (*ISBN*: 0521706106)
- Essentials of Medicinal Chemistry; Korolkovas and J. H. Burkhaltar, 2nd Edition, 2012, John Wiley & Sons.
- Text Book of Organic Medicinal and Pharmaceutical Chemistry, Wilson and Gisvold, 12th Edition, 1st Edition-1971.
- Handbook of Research on Advanced Phytochemicals and Plant-Based Drug Discovery, Ajeet Singh, 1st Edition, 2022, IGI Global.
- Bioactives and pharmacology of medicinal plants, Volume 2, *Edited ByT. Pullaiah,* 1st Edition, 2022, Apple Academic Press.
- Phytochemistry and Pharmacology of Some Indian Medicinal Plants
- Km Ruby, Rajani Chauhan, Jaya Dwivedi, 1st Edition, 2012, Lambert Academic Publishing.
- The Phytochemical and Pharmacological Aspects of Ethnomedicinal Plants, V. R. Mohan , P. S. Tresina , A. Doss (Editor), 1st Edition, 2021, Apple Academic Press.
- Natural Products Pharmacology and Phytochemicals for Health Care Methods and Principles in Medicinal Chemistry; Debarshi Kar Mahapatra, Cristóbal Noé Aguilar, A. K. Haghi, (Editor), 1st Edition, 2021, Apple Academic Press.

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Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Chemistry)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSCH31102	**Course Name**	Paper IV: Ph.D. Chemistry Coursework Paper IV	

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
2	0	2	0	50	50	100

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Syllabus for Ph.D. Coursework in Computer Science Paper-III and IV

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences

Faculty	Science	**Program**	Ph.D. (Computer Science)
Year	1	**Version**	3.0
Semester	1/2	**Effective From**	April, 2025
Course Code	PSCS31101	**Course Name**	Paper III: Ph.D. Computer Science Coursework Paper III

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
4	4	0	0	50	50	100

Syllabus for Ph.D Course Work in Computer Science
(Paper III : Recent Advances in Computer Science)

PART - A	Elective - I	30 Hrs
PART - B	Elective - II	30 Hrs
		4 Credits (60 Hrs.)
* Any two distinct electives from following list of coursework electives to be opted by research scholar for the subject under the guidance of supervisor.		
Coursework Electives		1. Data Science and Data Analytics 2. Machine Learning 3. Digital Image Processing 4. Network Security and Cryptography 5. Natural Language Processing 6. Neural Network and Deep Learning
Evaluation methodology		Evaluation-1- MCQ test and Practical hands-on / Project presentation on relevant tools and technologies. Evaluation-2 Literature review / Survey / Field Study / Comparative study and it's presentation.

Elective: Data Science and Data Analytics

Unit 1 Basics of Data Science

- Data Acquisition : Data sources - Web APIs, Open Data Sources, Data APIs, Web Scrapping
- Data Pre-processing and Preparation
- Data Quality and Transformation: Data imputation, Data Transformation (minmax, log transform, z-score transform etc.,), Outlier/Noise& Anomalies
- Handling Text Data : Bag-of-words, Regular Expressions, Sentence Splitting and Tokenization , Punctuations and Stop words, Incorrect spellings, Properties of words and Word cloud, Lemmatization and Term-Document TxD computation, Sentiment Analysis (Case Study)

Unit 2 : Statistical Decision Making

- Data Visualization: Science of Visualization, Visualization Periodic Table, Concepts of measurement - scales of measurement, Design of data collection formats, Principles of data visualization - different methods of presenting data in business analytics, Visualization types, Visualization charts
- Sampling and Estimation: Sample versus population, Sample techniques (simple, stratified, clustered, random), Sampling Distributions, Parameter Estimation, Unbalanced data treatment
- Inferential Statistics: Develop an intuition how to understand the data, attributes, distributions, Procedure for statistical testing, etc., Test of Hypothesis (Concept of Hypothesis, testing, Null Hypothesis and Alternative, Hypothesis)

Unit 3 : Predictive Analytics

- Linear Regression, Regression basics: Relationship between attributes using Covariance and Correlation, Relationship between multiple variables: Regression (Linear, Multivariate) in prediction, Residual Analysis, Identifying significant features, Hypothesis testing of Regression Model

Unit 4 : Big Data Analytics

- Challenges of processing Big Data
- Big Data Frameworks – Hadoop, Spark and NoSQL Systems
- Essential Algorithms (Word count, Page Rank, IT-IDF), Spark: RDDs, Streaming and Spark ML

Elective: Machine Learning

UNIT 1 : Introduction Machine Learning
Introduction: Defining learning systems, Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation, supervised learning, unsupervised learning, learning algorithms.
Scalable Machine Learning - Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models

UNIT 2 : Decision Tree based Learning
Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity, Overfitting, noisy data, and pruning.,

UNIT 3: Supervised and Unsupervised Learning Methods
Support Vector Machines: Maximum margin linear separators. Kernels for learning non-linear functions. Bayesian Learning: theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies. Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbour algorithm, Case-based learning.

UNIT 4: Ensemble Learning
Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory. Ensemble Learning: Bagging, boosting, and Ada-Boost. Experimental Evaluation of Learning Algorithms, Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.

Study and review of latest tools, technologies and research trends of Machine Learning,Study of Research projects, Research design and Research Evaluation in Machine Learning.

REFERENCES:-

1. Machine Learning – Tom M. Mitchell, - MGH
2. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Taylor & Francis (CRC)
3. Machine Learning Methods in the Environmental Sciences, Neural Networks, William WHsieh, Cambridge University Press.
4. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc., 2001
5. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
6. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012, Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009

Elective: Digital Image Processing

Unit 1 Digital Image Fundamentals

Definition of digital image, pixels, representation of digital image in spatial domain as well as in matrix form, Block diagram of fundamentals steps in digital image processing, Applications of digital image processing system, Light, brightness adaption and discrimination, Image as a 2D data, Image representation Gray scale and Colour images

Unit 2 Image Enhancement, Filter in Spatial Domain and Image restoration

Intensity transformation functions, Contrast stretching, Thresholding, Image negative, Log transformation, Power-low transformation, Image histogram, Histogram equalization process, Fundamentals of spatial filtering, Correlation and convolution, Spatial filtering mask for low pass filtering (smoothing) and high pass filtering (sharpening), Homomorphic filtering, 2D-DFT, 2DFFT, 2D- DCT, Fundamentals of 2D-wavelet transform, Reasons for image degradation, Image restoration using spatial filtering (Mean filters, Order statistic filters, adaptive filters)

Unit 3 Image Compression & Image Segmentation

Fundamentals of redundancies, Basic Compression Methods: Huffman coding, JPEG Compression standard, Wavelet based image compression, Edge based segmentation, Region based segmentation, Optimal thresholding.

Unit 4: Morphological Image Processing and Image Analytics

Basic morphological operations, Erosion, dilation, Structuring elements, Hit-or-Miss transform, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons, Reconstruction by erosion and dilation, Feature extraction, Feature selection

Study and review of latest tools, technologies and research trends of Digital Image Processing,Study of Research projects, Research design and Research Evaluation in Digital Image Processing.

Reference books:

1. Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Third Edition, Pearson Education
2. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill Publication
3. Digital Image Processing, S Sridhar, Oxford University Press

Elective: Network Security and Cryptography

(30 Hours)

Unit 1: Security basics and attacks

Phishing, various attacks and their prevention, privacy preservation. data reconnaissance, active attack, passive attack, spoofing, spamming, cyber defamation, salami attack, data diddling. Introduction to threats, vulnerabilities, integrity, confidentiality, anonymity, authentication, authorization, non-repudiation, plain text, cipher text, encryption and decryption.

Unit 2: Cryptography

Introduction to cryptography, cryptosystems, cryptanalysis, basic concepts of public key and private key cryptography, symmetric-asymmetric encryption, classical encryption algorithms.
Secret Key Cryptography: DES, Triple DES, AES, Key Distribution.
Public Key Cryptography: RSA, ECC, Key Exchange.
Public Key Infrastructure: Digital Certificates, Certification Authorities.

Unit 3: Message Authentication process and protocols

Hash Functions, MAC, Digital Signature,
Protocols used in security: Authentication Protocols, Needham Schroeder Protocol, Kerberos, Network Security with IP Security, Web Security using SSL, SET, System Security using Firewalls and VPN

Unit 4: Other Security Aspects

Security audit and logs, Smart Cards security, Zero knowledge protocols, Enterprise Application Security, Biometric Authentication, Database Access Control, Security and Privacy Issues in RFIDs.

Study and review of latest tools, technologies and research trends of Network Security and Cryptography, Study of Research projects, Research design and Research Evaluation in Network Security and Cryptography.

Reference books:

1. Cryptography and Network Security by William Stallings
2. Security in Computing by Pfleeger and Pfleeger, 3rd Edition, PHI,
3. Computer Security: Art and Science by Bishop, Pearson Edition
4. Computer Security by Gollmall, Willey Publication
5. Network Security by Kaufman, Pearson Edition

Elective: Natural Language Processing and Text Mining

Unit 1: Basic Linguistics

Parts of speech, Noun vs. verb and other "senses" of a word and their effect on analytics, 'Nyms' – homonyms, synonyms, troponyms, meronyms, and other variants, Stopwords, dictionaries, and taxonomies, Stemming, Lemmas, and other concepts, Dealing with contractions and other specialized forms

Unit 2: Language analysis & Tokenization

Extracting meaning from text, Humans parse language, Understanding complexity, Preparing to analyze texts, The process of text analysis, Space-based vs. NLP style tokenization, Various tokenizer models

Unit 3: Part-of-Speech (POS) tagging and Named Entity Recognition (NER), Sentiment Analysis, Topic Modeling

Introduction to POS tagging, Stop words and dictionaries, Introduction to NER, Lesk Algorithm and Word Sense Disambiguation (WSD), Sentiment Analysis, Tools and techniques, Limitations, Extracting topics from a document corpus, Strategies, methods, and outcomes

Unit 4: Ontologies, Taxonomies, and Dictionaries, Semantic technology

Taxonomy basics, Applications to machine learning, Ontologies, Dictionaries, Overview of Semantic Technologies

Study and review of latest tools, technologies and research trends of Natural Language Processing,Study of Research projects, Research design and Research Evaluation in Natural Language Processing.

Reference Books:

1. Srinivasa-Desikan, Bhargav, Natural Language Processing and Computational Linguistics, Pakt 2018
2. Natural Language Processing and Information Retrieval-By bSiddiqui and Tiwari, Oxford University Press
3. Speech and Language Processing - By Jurafsky and Martin, Pearson Education
4. Natural Language Processing with Python. – Analyzing Text with the
5. Natural Language Toolkit. Steven Bird, Ewan Klein, and Edward Loper, O'relly publication
6. The Oxford Handbook of Computational Linguistics 2nd edition Edited by Ruslan Mitkov, Oxford Press

Elective : Neural Network and Deep Learning

Unit 1: Foundation of Neural Network
Biological Inspiration, Artificial Neural Network, Structure of a neural net (topology), Models of Neuron, Neural Network Architectures, Artificial Neuron, Multilayer Perceptron, weights, bias, Activation Function, Loss function, Epochs, Threshold function.
Mathematical Concepts for Neural Network: Scalars, Vectors, Matrices, Tensors, Hyperplanes, Products, Feature, Solving Systems of Equations, Hyperparameters and Convergence, Gradiant Decent, Evaluation Metrics

Unit 2 : Architectures of Neural Network
Types of ANN, Feed Forward Neural Network, Backpropagation Neural Network, Error calculation in ANN, Input Layer, Output Layer, Hidden Layers of Deep Neural Network, Case Study of Classifying movie reviews using ANN

Unit 3: Deep Learning with Neural Network
Concept of Deep Learning, Applications of areas Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks and Implementation, LSTM and GRU

Unit 4 Advanced Topics in Deep Learning
Attention Mechanisms, Generative Adversarial Networks (GANs), Training a Generative Adversarial Network , Transformers e.g. BERT, pre-trained Models in Deep Learning.

Study and review of latest tools, technologies and research trends of ANN and Deep Learning,Study of Research projects, Research design and Research Evaluation in ANN and Deep Learning.

Reference Books:

1. Deep Learning with Python, Manning Franci Cohlet
2. Fundamentals of Deep Learning, Orelly, Nikhil Buduma
3. Deep Learning: A Practitioner's Approach, Josh Patterson , Adam Gibson O'relly Publications
4. Neural Networks and Deep Learning, A Textbook - Springer, Chru C Agrawal
5. Fundamentals of Deep Learning - Nikhil Buduma, O'relly Publications

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Computer Science)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSCS31102	**Course Name**	Paper IV: Ph.D. Computer Science Coursework Paper IV	

Teaching Scheme				Examination Scheme		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
2	0	2	0	50	50	100

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Faculty of Science

Syllabus for Ph.D. Coursework in Mathematics Paper-III and IV

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Mathematics)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSMA31101	**Course Name**	Paper III: Ph.D. Mathematics Coursework Paper III	

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
4	4	0	0	50	50	100

SARVAJANIK UNIVERSITY
Department of Mathematics

Faculty of Science

Course Work for Ph. D. Mathematics Students

Every student admitted in Mathematics for the Ph. D. programme will be required to pass a course work of 4 credits.

Sr. No.	Content	Hrs.
1	**Complex Analysis** Elementary properties of analytic functions and complex integration, Cauchy's Theorem and Its Applications, Meromorphic functions, singularities, conformal mappings **Suggested Readings:** 1. Conway J.B. ,Functions of one Complex Variables, Springer/ Narosa, New Delhi. 2. Advanced Engineering Mathematics Erwin Kreyszig, Wiley India.	6
2	**Abstract Algebra** Groups, Basic Definitions, Subgroups, Cosets and Lagrange's Theorem, Finitely Generated Groups, Permutation Groups and Group Actions, Finite Symmetric Groups, Normal Subgroups and Isomorphism Theorems, Direct Products and Direct Sums, Finite Abelian Groups . **Suggested Readings:** 1. Malik, D. S., Fundamentals of Abstract Algebra, New York, McGraw hill book Co, 1997 2. Vasishtha, A.R, Modern Algebra: Abstract Algebra, Meerut : Krishna Prakashan Mandir , 1990	6
3	**Ordinary Differential Equations** Ordinary differential equation, asymptotic stability, existence uniqueness theorems, Sturm Liouville problems and eigen values, Introduction to systems of Differential Equations **Suggested readings :** 1. Bala, O. Ratan Ordinary Differential Equations: An Introductory Treatment with applications, New Delhi Allied pub. Pvt. Ltd ,2003. 2. Codddington Earl A,/Levinson, Norman , Theory of Ordinary Differential Equation, New Delhi, Tata McGrow Hill Publishing	6

	Co. Ltd., 2006	
4	**Partial Differential Equations** First order PDE: method of characteristics, wave equation, weak solutions, system of PDE. Linear PDE: dimensional analysis and self similarity, regular and singular perturbation, asymptotic and complete solution. Non-linear PDE: conversion of non-linear PDE into linear PDE, some exactly solvable cases, Burger's equation, singular perturbation: boundary layer idea. **Suggested Readings:** **1.** M. K. Jain, S. R. K. Iyengar and R.K. Jain: Numerical methods for scientific and engineering computation, Wiley Eastern Ltd. Third Edition, 1993 **2.** Prasad Phoolan, Ravindran R. Partial Differential Equation, New age International pvt. Ltd., 1996.	6
5	**Laplace and Fourier Transform** Introduction to Laplace Transform, Properties and its application to solve Differential Equations, Fourier Integral representation, Fourier sine and cosine transform and applications **Suggested Readings:** 1. Dyke, P.P.G, Introduction to Laplace Transforms and Fourier Series, Springer(India)Pvt. Ltd.2006, 2010 2. Schiff Joel L., Laplace Transform: Theory and Applications, New Delhi Springer(India)Pvt. Ltd.2005	9
6	**Boundary Layer Theory** Fundamental equations of motion, Derivation of Reynolds's principal of similarity from the Nevier-Stokes equations, Frictionless flow as "Solutions" of the Nevier-Stokes equations, Nevier-Stokes equations interpreted as vorticity transport equations, Limiting cases of very large viscosity (very small Reynolds number) and very small viscous forces (very large Reynolds number) **Suggested readings :** 1. Boundary Layer Theory by H. Schlichting, McGraw-Hill Book Company, New York, 1987	9
7	**Numerical Techniques** Boundary Value Problems, Finite difference method, Difference scheme based on quadrature formulas, solution of tridiagonal system, boundary conditions at infinity Partial Differential Equations: Parabolic, Elliptic and Hyperbolic differential equations subject to Dirichlet's, Neumann (or flux) and mixed (or Robin or Radiation) conditions, Basic concept of finite difference and finite element method, weak formulation of BVP. **Suggested Readings:** 1. M. K. Jain, S. R. K. Iyengar and R.K. Jain: Numerical	9

	methods for scientific and engineering computation, Wiley Eastern Ltd. Third Edition, 1993 2. S.C. Chapra and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi	
8	Mathematical and Statistical Softwares MATLAB – Introduction to MATLAB. MATLAB basics. **Suggested Readings:** 1. Pratap, Rudra, Getting Started with MATLAB 5: A Quick Introduction for Scientists and Engineers, Delhi : Oxford University press , 1999 2. Harris, Sandra L. Applied Numerical Methods for Engineers: Using Matlab and C, New York, Books/Cole Thomson Learning, 2000	9

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Mathematics)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSMA31102	**Course Name**	Paper IV: Ph.D. Mathematics Coursework Paper IV	

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
2	0	2	0	50	50	100

SARVAJANIK UNIVERSITY
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Faculty of Science

Syllabus for Ph.D. Coursework in Microbiology Paper-III and IV

SARVAJANIK UNIVERSITY

Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Microbiology)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSMB31101	**Course Name**	Paper III: Ph.D. Microbiology Coursework Paper III	

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
4	4	0	0	50	50	100

SARVAJANIK UNIVERSITY

Faculty of Science

Syllabus for PhD Course Work in Microbiology

Name of faculty: Science	**Department:** Microbiology
Program: Ph.D. Course work	**Type:** Theory
Subject: Microbiology	**Total learning hours:** 60

Course description:

- This course gives a broader insight about the principles & applications of modern techniques used in the different area of research in microbiology like Microbial taxonomy, Fermentation technology, Immunology, clinical microbiology, rDNA technology, Environmental Microbiology, Bioinformatics along with analytical & separation techniques.

Student learning outcome:

- Students will able to understand principles, applications & limitations of modern techniques used in microbiological research.
- Students will develop rational approach in selection of techniques.
- Understand, analyze and interpret results generated through use of different techniques.
- Develop understanding about applications of various bioinformatics tools.

Unit I: Molecular Taxonomy **(Duration: 08 Hrs)**

Importance of 16S rRNA in taxonomy & phylogeny. 16S rDNA amplification. Southern, Northern, Western and Dot blotting. Principles and techniques of Southern and Northern hybridization. Principles and applications of PCR, RT-PCR, and qPCR. DNA Microarrays / Chips. DNA Sequencing Methods – Sanger, Maxam – Gilbert, Next Generation Sequencing (NGS).

Unit II: Fermentation Technology **(Duration: 07 Hrs)**

Types of fermentation process – Aerobic, anaerobic, Submerged, solid state, batch, continuous and fed-batch. Screening of new metabolites, Mechanically & non-mechanically agitated fermenters. Culture media- types, components and formulations. Optimization of a fermentation process – classical & statistical methods. Enzyme & whole cell immobilization. Downstream process.

Unit III: Immunology and Immunoassay **(Duration: 08 Hrs)**

Complement fixation. Structure and classes of antibodies. Genetic basis of antibody diversity. MHC I and II: structure and antigen presentation. T and B lymphocytes activation and role in humoral and cell mediated immunity.
Immuno-assays: SRID (Single Radial Immunodiffusion), ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluroscens and their application.
Vaccines: Live and attenuated, killed, multi-subunit and DNA vaccines.

Unit IV: Clinical Microbiology **(Duration: 07 Hrs)**

An introduction of human microbiome project, Human gut/oral/skin microbiota, current research methods of microbiome analysis including culture-dependent and culture-independent tools. Evolution and molecular mechanisms of antimicrobial resistance, Multi-drug resistance, Factors contributing the emergence of antimicrobial resistance Antimicrobial susceptibility testing, Case studies on Tuberculosis with emergence of MDR, XDR and TDR TB. Automation in identification of human pathogens. Culture preservation methods. Culture collection centers.

UNIT V: rDNA Techniques **(Duration: 07 Hrs)**

Restriction mapping - RFLP, Cloning strategies. cDNA and genomic DNA library construction and screening of libraries. PCR based DNA finger printing –Random Amplified Polymorphic DNA (RAPD), Amplified fragment length polymorphism (AFLP), Short tandem repeat (STR) and LTR analysis. Yeast two hybrid system, Screening of recombinants - Antibiotic resistance, lacZ complementation (Blue-white selection), fluorescent markers (e.g. GFP).

UNIT VI: Environmental Microbiology **(Duration: 08 Hrs)**

Bioremediation: Concept of bioremediation (in-situ & ex-situ). Bioremediation of organic compound contaminants. Bioremediation of heavy metal: Microbial metal resistance, Microbial transformation, accumulation and concentration of metals. Bioremediation of pesticides, oil and textile effluent. Use of GMOs in bioremediation.
Biodegradation: Role of super bug strains in xenobiotic degradation.
Water and waste water microbiology: Methods of Water pollution monitoring - Biological methods (Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count, Multiple tube method, Membrane filtration methods, Enzyme detection, Hybridization, PCR, Gene probe technology etc.) Chemical methods (Detection methods for COD, pH, alkalinity,

TSS, TDS, Total organic carbon, oil, grease etc.). Treatment of waste water - Primary, secondary and tertiary treatments. Biological treatments - aerobic versus anaerobic treatments. Bioreactors for waste water treatments.

UNIT VII: Separation and Analytical Techniques **(Duration: 08 Hrs)**

Centrifugation - Preparative and analytical, ultra-centrifugation, Density gradient centrifugation.
Chromatography – Gel filtration, Ion Exchange, Reverse phase chromatography, TLC, HPLC & UHPLC, Nano-LC.
Spectroscopy – IR, NMR, Mass Spectroscopy, AAS, X-ray crystallography.
Electrophoresis – PAGE, SDS-PAGE, Agarose, Pulsed Field Gel Electrophoresis (PFGE), Two dimensional electrophoresis, Density Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE) and TRFLP (Terminal Restriction Fragment Length Polymorphism).
Microscopy – Cryo EM, CLSM, Photo-activated localization microscopy
Radiography - GM counter & Scintillation counting methods. Use of Radioisotopes in biological sciences.

UNIT VIII: Bioinformatics **(Duration: 07 Hrs)**

Genbank sequence databases – NCBI, EMBL and DDBJ.
Retrieving database entries. Submission of rDNA sequences – Bankit & Sequin guidelines.
Structural databases (PDB, MMDB, FSSP, SCOP, BRENDA). Metabolic databases. Proteome databases (protein sequence database, SWISS-PROT, TrEMBL). Sequence alignment. Data analysis tools (BLAST & FASTA).
Phylogenetic analysis. Secondary and 3D structure prediction using DNA and protein sequences. Tools for Gene prediction, Protein structure & functions prediction, Designing primers & probes. Drug design.

Reference Book:

- Arceivala S. J. and Asolekar S. R (2007)Waste Water Treatment for Pollution Control and Reuse 3rd edition Mc Graw Hill Education India Pvt Ltd. (ISBN:978-0-07-0620995)
- Brown, T. A. (2020). Gene cloning and DNA analysis: an introduction. John Wiley & Sons (ISBN: 9781405181730).
- Chandar, N., & Viselli, S. (2012). Cell and molecular biology. Lippincott Williams & Wilkins (ISBN: 978781792103).
- Chaudhuri, K. (2013). Recombinant DNA technology. The Energy and Resources Institute (TERI) (ISBN: 9788179933206).
- Ghosh, Z., & Mallick, B. (2008). Bioinformatics: principles and applications. Oxford University Press. (ISBN: 0195692306)
- Glick, B. R., & Patten, C. L. (2017) Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). John Wiley & Sons. (ISBN: 1555812244).
- Jonathan Pevsner, (2009). Bioinformatics and functional genomics, Wiley–Blackwell, 2nd edition (ISBN: 0470085851).
- Khandpur R.S. (2009) Handbook of Analytical Instrument 2nd Edition Tata McGraw Hill Publishers. (ISBN: 9780070604605)

- Khopkar S.M. (2009) Basic Concepts of Analytical Chemistry 3rd Edition,New Age International (P) Limited, Publishers.(ISBN: 9781906574000)
- Lewin, B. (2008). Genes IX. Jones Barlett Publ. (ISBN: 0763740632)
- Malathi, V. (2013). Essentials of molecular biology. Pearson (ISBN: 8131773213)
- Martin Alexander. Biodegradation and Bioremediation 2nd Edition, Academic press. (ISBN:978-0-12-049861-1)
- Metcalf and Eddy (2003) Waste Water Engineering Treatment and Reuse. McGraw Hill Education (India) 4th edition.(ISBN:978-0-07-049539-5)
- Metcalf and Eddy (2003) Waste Water Engineering Treatment and Reuse. McGraw Hill Education (India) 4th edition. (ISBN:978-0-07-049539-5)
- Mitra, S. (1996). Genetic engineering: principles and practice. McGraw-Hill Education, (ISBN: 978-9339203535).
- Mohapaatra P. K. (2006) Textbook of Environmental Biotechnology I.K. International Publishing House Pvt ltd. ISBN 81-88237-54-X
- Mount d. W (2005). Bioinformatics sequence and genome analysis, CBS, 2nd edition, (ISBN: 8123912412)
- Mukesh Doble and Anil Kumar (2005) Biotreatment of Industrial Effluents. Butterworth-Heinemann. (ISBN 978-0-7506-7838-4)
- Nicholl, D. S. (2008). An introduction to genetic engineering. Cambridge University Press, (ISBN: 9780521850063).
- Owen, Judith A., Punt Stanford, Sharon A., Jones, Patricia P., Kuby Immunology,7th ed. Macmillan Higher education Pub. (ISBN: 9781464189784)
- Pal, J. K., & Ghaskadbi, S. S. (2009). Fundamentals of Molecular Biology. Oxford University Press (ISBN: 9780195697810).
- Pierce, B. A. (2012). Genetics: a conceptual approach. Macmillan, (ISBN: 9781319297145).
- Prescott M, Harley John P., Microbiology, 9th edition, Lansing, Donald A. Klein, McGraw Hill. (ISBN: 9780077467890)
- Primrose, S. B. & Twyman, R. (2009). Principles of genome analysis and genomics. John Wiley & Sons. (ISBN: 9781405101202)
- Rastogi, S. C. (2006). Cell and molecular biology. New Age International (ISBN: 8122414877).
- Rastogi, S. C., Rastogi, P., & Mendiratta, N. (2008). Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery 3rd Ed. PHI Learning Pvt. Ltd. (ISBN: 8120347854)
- Reece, R. J. (2004). Analysis of genes and genomes. Hoboken, NJ: John Wiley & Sons. (ISBN: 9780071077798).
- Roitt I. M., Essential Immunology, 6th Ed. ELBS, London (ISBN: 9780865427297)
- Smita Rastogi and Neelam Pathak (2009) Genetic Engineering, Oxford University Press; (ISBN: 0195696573).
- T.M.Schmidt and M.Schaechter (2012). Topics in Ecology and Environmental Microbiology Edited by Academic Press (ISBN:978-0-12-383878-0)
- Watson, J. D. (2004). Molecular biology of the gene. Pearson Education India. (ISBN: 9332585474)
- Xiong, J. (2006). Essential bioinformatics. Cambridge University Press. (*ISBN*: 0521706106)

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SARVAJANIK UNIVERSITY

Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences					
Faculty	Science		**Program**	Ph.D. (Microbiology)	
Year	1		**Version**	3.0	
Semester	1/2		**Effective From**	April, 2025	
Course Code	PSMB31102	**Course Name**	Paper IV: Ph.D. Microbiology Coursework Paper IV		

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
2	0	2	0	50	50	100

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Faculty of Science

Syllabus for Ph.D. Coursework in Physics Paper-III and IV

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences				
Faculty	Science		**Program**	Ph.D. (Physics)
Year	1		**Version**	3.0
Semester	1/2		**Effective From**	April, 2025
Course Code	PSPH31101	**Course Name**	Paper III: Ph.D. Physics Coursework Paper III	

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
4	4	0	0	50	50	100

SYLLABUS OF Ph.D. (SCIENCE) COURSE WORK IN PHYSICS

Ph.D. (PHYSICS) COURSE STRUCTURE							
Semester-1/2 (15 weeks)							
Sr. No.	Course Code	Course Name	L	T	P	Credit	Hours
1	PSPH31101	Experimental Techniques in Material Sciences	4	0	0	4	60

Course Objectives:

- To teach scholars some of the basic concepts of experimental methods of physics in research
- To prepare and specialize them for research in advanced fields of experimental physics and make the scholars well conversant with useful instruments, techniques and procedures to study properties of materials for research.

Course Outcome:

- After attending the course, the scholars will have advanced analytical abilities of experimental research to characterize materials and devices based on microscopic, spectroscopic, compositional, crystalline structural, electrical, mechanical, magnetic and thermal characterization techniques

Experimental Techniques in Material Sciences			
Module No.	Module Content	Teaching Hours	Module Weightage
1	**Fundamentals of Synthesis and Fabrication of Materials:** Classification of powders; Synthesis of powders, **Material Synthesis:** Solid State Reaction, Various growth techniques like sol-gel, wet-chemical method, Hydrothermal, Combustion Technique etc. **Crystal Growth:** Growth of single crystals, Introduction to methods of growth of crystals, Czocheralski method, Bridgeman and Stockberger methods, Zone melting and zone refining methods, Impurity leveling, Verneil method, Molten Flux method	8	13%
2	**Sample preparations:** preparations of thin film, spin coating, vacuum evaporation sputtering, pulsed laser deposition, Vapor phase transport methods, Fundamental of epitaxial growth of thin layers **Synthesis of nanomaterials**: Bottom-up approach and Top-down approach with examples, Various fabrication and synthesis	8	13%

	techniques such as Ball Milling, Chemical bath Deposition, Electrodeposition, Sol-Gel, Physical Vapor Deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy.		
3	**Films and surfaces:** Synthesis of thin films: Spin coating, Dip coating, Thermal and electron beam evaporation, Pulsed laser deposition; General concept of lithography, Photolithography, Electron beam lithography; Clean room **Vacuum Generation and Measurement Techniques:** Introduction to vacuum, gas law; Rotary vane pump, Turbomolecular pump, Cryo pump; Pirani gauge, Penning gauge Preparation-Thermal Vapour Deposition, Chemical Vapour Deposition, laser ablation, Molecular Beam Epitaxy, study of surface topography by multiple beam interferometry, conditions for accurate determination of step height and film thickness Fizeau fringes, Electrical conductivity of thin films, difference of behaviour of thin films from bulk material, expression for electrical conductivity for thin film	7	12%
4	**Compositional Characterization Techniques:** Structure determination of solids: Crystal symmetry, Bravais lattice; transformation of crystal Lattice, point groups; space groups , Direct methods of crystal structure determination, X-ray Diffraction, Energy Dispersive X-ray Analysis (EDAX), X-ray Fluorescence Spectroscopy, particle size determination through DLS, elementary concepts of surface crystallography, Thermal analysis, Differential Scanning Calorimeter (DSC), Thermo-Gravimetric and Differential Thermal Analyzer (TG-DTA), Differential Scanning Calorimetry, Photoluminescence,Electroluminescence, Hardness measurements	11	18%
5	**Microscopic Techniques**: Optical Microscopes (Bright field, Confocal, Super-resolution), Scanning Electron Microscope, Scanning Probe Microscopes, Transition Electron Microscopy, Atomic Force Microscopy, Thermoluminescence Measurements	4	7%
6	**Electrical characterization techniques:** Measurement of resistivity by four-probe method, Impedance and ferroelectric measurements, Hall effect and Hall Coefficient for two carrier types, origin of positive Hall coefficient for metals, Dielectric Measurements, I-V characteristics, C-V Characteristics	8	13%
7	**Spectroscopy Techniques:** Photoluminescence Emission (PL) and Excitation (PLE) spectroscopy; Infrared (IR), Fourier Transform infrared (FTIR) Spectroscopy and Raman spectroscopy; X-ray Absorption (XAS), UV-Visible spectroscopy, Fluorescence, Vibrational Spectroscopy for molecular analysis, Infra-red Spectroscopy, Nuclear Magnetic Resonance (NMR), Electron Paramagnetic Resonance Spectroscopy (EPR)/Electron Spin Resonance (ESR)	9	15%
8	**Luminescence and its Applications:** Principle – Theory – Types-Working – Measurements and applications, study of	5	8%

	Thermoluminescence as a research tool to investigate luminescence mechanism, Dosimetric Characterization, Recent advances and applications in various emerging applications		
	Total	60	100%

Few Reference Books:

1. Compound Semiconductor Bulk Materials and Characterizations by (author): Osamu Oda (*Aichi Science & Technology Foundation, Japan*) Pages: 556, ISBN: 978-981-02-1728-0
2. Handbook on Crystal Growth by Tatau Nishinaga
3. Introduction to Crystal Growth: Principles and Practice by H. L. Bhat
4. Physics of Semiconductor Devices by Author(s):S.M. Sze, Kwok K. Ng, First published:10 April 2006, Print ISBN:9780471143239 |Online ISBN:9780470068328
5. Fundamentals of Semiconductor Fabrication by Gary S. May, Simon M. Sze, ISBN: 978-0-471-23279-7, April 2003, 320 Pages
6. Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press, 2004 - Science - 433 pages
7. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition by Yang Leng, ISBN: 978-3-527-33463-6 , September 2013, 392 Pages
8. Advanced Characterization Techniques for Thin Film Solar Cells, Editor(s):Dr. Daniel Abou-Ras, Dr. Thomas Kirchartz, Prof. Dr. Uwe Rau, First published:7 April 2011, Print ISBN:9783527410033 |Online ISBN:9783527636280
9. Advanced Techniques for Materials Characterization by A. K. Tyagi, Mainak Roy, S. K. Kulshreshtha and S. Banerjee, pages 528, Year 2009, ISBN 9780878493791, eBook: ISBN 9783038133230
10. Handbook of Materials Characterization by Surendra Kumar Sharma
11. Solid Surfaces, Interfaces and Thin Films by Hans Lüth, ISBN: 978-3-319-10756-1
12. Handbook of Spectroscopy: Second, Enlarged Edition,Editor(s):Prof. Dr. Günter Gauglitz, Dr. David S. Moore, First published:2 April 2014, Print ISBN:9783527321506 |Online ISBN:9783527654703 |DOI:10.1002/9783527654703, Copyright © 2014 Wiley-VCH Verlag GmbH & Co. KGaA
13. Luminescence And Its Applications Paperback – 1 January 2007, by S Selvasekarapandian
14. Luminescence - An Outlook on the Phenomena and their Applications by Jagannathan Thirumalai, Year2016, ISBN978-953-51-2763-5, PRINT ISBN978-953-51-2762-8, EBOOK (PDF) ISBN978-953-51-4153-2
15. Concept of Physics by HC Verma
16. Problems on General Physics by IE Irodov
17. Fundamentals of Physics by Halliday Resnick and Walker
18. University Physics by Francis W. Sears, Hugh D. Young, Roger Freedman, Mark Zemansky

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		**Program**	Ph.D. (Physics)		
Year	1		**Version**	3.0		
Semester	1/2		**Effective From**	April, 2025		
Course Code	PSPH31102	**Course Name**	Paper IV: Ph.D. Physics Coursework Paper IV			

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
2	0	2	0	50	50	100

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Syllabus for Ph.D. Coursework in Statistics Paper-III and IV

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences					
Faculty	Science		**Program**	Ph.D. (Statistics)	
Year	1		**Version**	3.0	
Semester	1/2		**Effective From**	April, 2025	
Course Code	PSST31101	**Course Name**	Paper III: Ph.D. Statistics Coursework Paper III		

Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
4	4	0	0	50	50	100

SARVAJANIK UNIVERSITY
Faculty of Science

Name of the Faculty: Science	**Course Code: PSST31101**
Name of the Programme: Ph.D. Statistics	**Credits: 04**
Subject: Coursework Syllabus	**Duration: 60 hours**

Course Description:

Statistics is highly used in interdisciplinary field. It concerned with developing and studying methods for collecting, organizing, analyzing data and from that interpreting and drawing meaningful conclusion for the research in any discipline. This subject deals with uncertainty and variability in real life situations and also helps in giving answers to their research problems. Statistics provide tools and methods that gives deeper insight into data which analyze and quantify the uncertainty, patterns, and derive the appropriate inferences and assistance in taking concrete decisions.

Course Objectives:

1. To understand the statistical concepts and their application.
2. To expose students to a variety of statistical techniques for dealing with the challenges presented by a given data in different situations.
3. To expose students to the tools for data analysis.

Module	Content	Hours
1	**Probability and Decision making** 1. Risk and risk awareness, mean variance analysis, allocation between risky and risk-free portfolios. 2. Diversification and portfolio risk, Markovitz portfolio selection, optimal portfolio.	7
2	**Statistical Inference -Advance Multivariate Analysis** 1. Discriminant Analysis 2. Factor Analysis: EFA, CFA and Overview of SEM	7
3	**Design of Experiments** 1. BIBD- recovery of inter block information; Youden design – intra block analysis. 2. Response surface experiments, first order designs and orthogonal designs, clinical trials, longitudinal data, treatment- control designs. (Application Areas)	8
4	**Sampling and Statistical Quality Control** 1. Scientific sampling in SQC 2. Models for quality management and problem solving	8

5	**Econometrics** 1. The general linear model (GLM), Use of dummy variables and seasonal adjustment. 2. Heteroscedastic disturbances, Auto correlation, Multicollinearity problem its consequences and tests.	8
6	**Operation Research** 1. Matrix Algebra and Applications 2. Inventory Control and Models	7
7	**Biostatistics and Computing** 1. Introduction to clinical trials: Bias and random error in clinical studies, overview of Phase I-IV trials, multi-centre trials. 2. Data management and data analysis through R: Basics of R programming	8
8	**Statistical inference - Machine learning and AI** 1. Building machine learning models 2. Neural networks for regression and classification problems	7

Reference Books

1. Security Analysis and Portfolio Management, S.Kevin, PHI
2. R. Paneerselvam, Research Methodology, PHI.
3. Ghosh S., Rao, C. R., Design and Analysis of Experiments, Elsevier
4. Cochran and Cox(1992), Experimental Designs, Wiley Classics Library
5. Grant E.L and Leavenworth, Statistical Quality Control (2017), McGraw-Hill
6. D. Montgomery (2010), Introduction to Statistical Quality Control, Wiley
7. Anderson, Sweeney, Williams, Quantitative Methods for Business, Thomson
8. J.K. Sharma, Operations Research Theory and Applications, Sixth Edition (2016), Trinity Press.
9. Hamdy A Taha, Operations Research: An Introduction, Tenth Edition, (2017), Pearson.
10. Bratati Banerjee, Mahajan's Methods in Biostatistics for Medical Students and Research Workers, Eighth edition, Jaypee Brothers Medical Publishers
11. W.N. Venables & B.D.Ripley: Modern Applied Statistics with S plus, Springer
12. Sutton R.S. and Barto A. G., Reinforcement Learning, (2018), MIT Press

SARVAJANIK UNIVERSITY
Faculty of Science

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		**Program**	Ph.D. (Statistics)		
Year	1		**Version**	3.0		
Semester	1/2		**Effective From**	April, 2025		
Course Code	PSST31102	**Course Name**	Paper IV: Ph.D. Statistics Coursework Paper IV			
Teaching Scheme				**Examination Scheme**		
Credits	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Continuous Assessments (CA)**	**Term end examinations (TEE)**	**Total**
2	0	2	0	50	50	100