

Savitribai Phule Pune University

(Formerly University of Pune)

**Three Year Degree Program in
'Industrial Mathematics with Computer Applications'
(Faculty of Science & Technology)**

Revised Syllabi for

M.Sc.(Industrial Mathematics with Computer Applications)

Part-III

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from the Academic Year 2021-2022

Title of the Course: M. Sc. (Industrial Mathematics with Computer Applications)

Preamble:

Savitribai Phule Pune University has decided to change the syllabi of various faculties from June, 2019. M.Sc. (Industrial Mathematics with Computer Applications) course syllabus is revised to cater to the needs of credit based-semester and grading system. The changing scenario of higher education in India and abroad is taken into consideration to make this syllabus more oriented towards the applications of Mathematics and Computer Science in Research and Industry. The syllabus encompasses the subjects related to Industrial Mathematics, Core Computer Subjects as well as the Emerging Technologies in Computer Science. Theory Courses will create the foundation for the development of logical thinking and the Practical Courses gives hands on experience towards the Industrial Requirements.

Taking into consideration the rapid changes in science and technology and new approaches in different areas of Mathematics and related subjects, Board of Studies in Mathematics with consent of teachers of Mathematics and Computer Science from different colleges affiliated to University of Pune has prepared the syllabus of **M.Sc.(Industrial Mathematics with Computer Applications)**.

The course will follow the credit system of the Savitribai Phule Pune University to develop the syllabus the U.G.C. Model curriculums followed.

Aims:

- i) Give the students sufficient knowledge of fundamental principles, methods and a clear perception of the innumerable power of mathematical ideas and tools and knowledge of how to use them by modeling, solving and interpreting.
- ii) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.
- iii) Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skill, creative talent and power of communication necessary for various kinds of employment
- iv) Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

Objectives:

- i) A student should be able to recall basic facts about mathematics and should be able to display knowledge of conventions such annotations, terminology and recognize basic geometrical figures and graphical displays, state important facts resulting from their studies.
- ii) A student should get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved with mathematical reasoning.
- iii) A student should get adequate exposure to global and local concerns so as to explore many aspects of Mathematical Sciences.

iv) A Student should be able to apply their skills and knowledge, that is, translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

v) A student should be made aware of history of mathematics and hence of its past, present and future role as part of our culture.

vi) A student should be able to write necessary algorithms and programs in different languages as per the need of the industry

Course Outcome:

1. An ability to apply knowledge of mathematics and computer science in practice
2. An ability to identify, critically analyze, formulate and solve problems with comprehensive knowledge in the area of specialization
3. An ability to contribute by research and innovation to solve real life problems
4. An ability to devise and conduct experiments, interpret data and provide well informed conclusions
5. An ability to function professionally with ethical responsibility as an individual as well as in multidisciplinary teams with positive attitude.
6. An ability to communicate effectively
7. An ability to appreciate the importance of goal setting and to recognize the need for life-long reflective learning

Structure of the course:

Semester – V

T/P/E: Theory/Practical/Elective

T/P	Code	Course Title	Lectures/Week	No of Credits
T	MIM 501	Numerical Analysis	4	4
T	MIM 502	Computational Geometry	4	4
T	MIM 503	Data Analysis With Python	4	4
T	MIM 504	Digital Image Processing	4	4
P	MIM 505	Lab Work	4	4
E	MIM 506	Cryptography and Network Security	2	2
E	MIM 507	Internet of Things	2	2

Semester –VI

Code	Course Title	No of Credits
MIM 601	Industrial Project/Institutional Project	20

Details of Syllabus:

Semester V

MIM 501: Numerical Analysis

Unit 1. Iterative solutions of Nonlinear Equations [12 lectures]

- 1.1 Bisection Method
- 1.2 Fixed-Point iteration
- 1.3 Newton's method
- 1.4 Secant method
- 1.5 Acceleration of convergence
- 1.6 Newton's method for two nonlinear equations
- 1.7 Polynomial equation methods.

Unit 2. Polynomial Interpolation [10lectures]

- 2.1 The Lagrange interpolation polynomial
- 2.2 Divided difference interpolation
- 2.3 Aitken's Algorithm
- 2.4 Finite difference formulas
- 2.5 Choice of nodes and non convergence of polynomial interpolation

Unit 3. Systems of Linear equations [10 lectures]

- 3.1 Gauss elimination with partial pivoting
- 3.2 Error analysis
- 3.3 Matrix factorization methods (Doolittle reduction, Crout reduction)
- 3.4 Iterative refinement
- 3.5 Iterative techniques
- 3.6 Gauss-Seidel iteration

Unit 4. Numerical Calculus [11 lectures]

- 4.1 Numerical differentiation
- 4.2 Forward difference Quotient
- 4.3 Central difference quotient
- 4.4 Interpolatory quadrature (order of methods)
- 4.5 Newton-Cotes methods
- 4.6 Error estimates for trapezoidal rule and Simpson's rule

Unit 5. Numerical solution of Differential Equations [11 lectures]

- 5.1 Euler's method
- 5.2 Analysis of Euler's method
- 5.3 Order of Euler's method
- 5.4 Runge-Kutta method
- 5.5 One step modified and midpoint methods
- 5.6 Runge-Kutta methods for systems of equations.

Unit 6. The Eigen value problem

[6 lectures]

- 6.1 Power method
- 6.2 Eigen values of symmetric matrices
- 6.3 Jacobi method

Reference Books:

1. John H. Mathews : Numerical Methods for Mathematics, Science and Engineering (Prentice-Hall) 2nd Edition. Sections : 1.3, 2.1 to 2.7, 3.4 to 3.7, 4.2 to 4.4, 6.1 to 6.2, 7.1 to 7.4, 9.2 to 9.7, 11.1 to 11.2 2.
2. K. E. Atkinson : An introduction to Numerical Analysis (John Wiley Sons).
3. S. Sastry: Numerical Analysis

SEM V

MIM 502: Computational Geometry

Unit 1. Two dimensional transformation

[20 lectures]

- 1.1 Introduction
- 1.2 Representation of points
- 1.3 Transformations and matrices
- 1.4 Transformation of points
- 1.5 Transformation of straight lines
- 1.6 Midpoint transformation
- 1.7 Transformation of parallel lines
- 1.8 Transformation of intersecting lines
- 1.9 Transformation: rotations, reflections, scaling, shearing
- 1.10 Combined transformations
- 1.11 Transformation of a unit square
- 1.12 Solid body transformations
- 1.13 Transformation and homogeneous coordinates. Translation
- 1.14 Rotation about an arbitrary point
- 1.15 Reflection through an arbitrary line
- 1.16 Projection – a geometric interpretation of homogeneous coordinates
- 1.17 Overall Scaling
- 1.18 Point at infinity

Unit 2. Three dimensional transformations:

[20 lectures]

- 2.1 Introduction
- 2.2 Three dimensional – Scaling, shearing, rotation, reflection, translation
- 2.3 Multiple transformations
- 2.4 Rotation about – an axis parallel to coordinate axes, an arbitrary axis in space
- 2.5 Reflection through – coordinate planes, planes parallel to coordinate planes, arbitrary planes
- 2.6 Affine and perspective transformations
- 2.7 Orthographic projections
- 2.8 Axonometric projections
- 2.9 Oblique projections
- 2.10 Single point perspective transformations
- 2.11 Vanishing points

Unit 3. Plane Curves

[12lectures]

- 3.1 Introduction
- 3.2 Curve representation

3.3 Non – parametric curves

3.4 Parametric curves

3.5 Parametric representation of a circle and generation of circle

3.6 Parametric representation of an ellipse and generation of ellipse

3.7 Parametric representation of a parabola and generation of parabolic Segment

3.8 Parametric representation of a hyperbola and generation of hyperbolic segment

Unit 4. Space curves

[8lectures]

4.1 Bezier Curves – Introduction, definition, properties

4.2 Curve fitting (up to $n = 3$)

4.3 Equation of the curve in matrix form (upto $n = 3$)

Textbook:

D. F. Rogers, J. A. Adams, Mathematical elements for Computer graphics, Mc Graw Hill Intl Edition.

Reference books: -

Schaum Series, Computer Graphics. - M. E. Mortenson, Computer Graphics Handbook, Industrial Pres Inc

Semester V

MIM 503 Data Analysis With Python

- UNIT 1. Introduction To Python** [8Lectures]
- 1.1History of Python
 - 1.2Features of Python
 - 1.3Python Identifiers, Keywords and Indentation
 - 1.4Comments and document interlude in Python
 - 1.5Command line arguments
 - 1.6Getting User Input
 - 1.7Python Data Types
 - 1.8Python variables
 - 1.9Python Core objects and Functions.
- UNIT 2. Control Flow, Functions, Modules And Packages** [10 Lectures]
- 2.1Control Flow
 - 2.2Conditional blocks using if else and elif
 - 2.3Simple for and while loops in python, For loop using ranges, string, list and dictionaries, Loop manipulation using pass, continue, break and else Functions, Arguments,
 - 2.4Lambda Expressions, Function Annotations Modules
Organizing python projects into modules,
 - 2.5Importing own module as well as external modules, Packages, Programming using functions, modules and external packages
- UNIT 3. Data Structures** [3 Lectures]
- 3.1 Lists as Stacks
 - 3.2Queues
 - 3.3Comprehensions Tuples and sequences Sets Dictionaries
- UNIT 4. Python File Operation** [8 Lectures]
- 4.1 Reading config files in python
 - 4.2 Writing log files in python, Understanding read functions
read(), readline() and readlines()
 - 4.3Understanding write functions, write() and writelines()
 - 4.4 Manipulating file pointer using seek Programming using file operations
- UNIT 5. Object Oriented Programming** [5 Lectures]
- 5.1Overview of OOP
 - 5.2 Creating Classes and Objects
 - 5.3Accessing attributes, Built-In Class Attribute

5.4 Destroying Objects

UNIT 6. Regular Expression [7 Lectures]

- 6.1 Powerful pattern matching and searching
- 6.2 Power of pattern searching using regex Real time parsing of networking or system data using regex
- 6.3 Password, email, url validation using regular expression
- 6.4 Pattern finding programs using regular expression

UNIT 7. Database Interaction SQL [4 Lectures]

- 7.1 Database connection using python
- 7.2 Creating and searching tables Reading and storing config information on database
- 7.3 Programming using database connections

UNIT 8. Python For Data Analysis [10 Lectures]

8.1 **Numpy**: Introduction to numpy Creating arrays Using arrays and Scalars Indexing Arrays Array Transposition Universal Array Function Array Processing Array Input and Output

8.2 **Pandas**: What is pandas? Where it is used? Series in pandas Index objects Re index Drop Entry Selecting Entries Data Alignment Rank and Sort Summary Statics Missing Data Index Hierarchy

8.3 **Matplotlib**: Python For Data Visualization Welcome to the Data Visualization Section Introduction to Matplotlib

UNIT 9. Django Web Framework in Python [5 Lectures]

- 9.1 Introduction to Django
- 9.2 Introduction to Full Stack Web Development

References:

1. Learning Python O'Really Publication
2. Programming Python, O'Really Publication
3. Python for Everybody: Exploring data using Python3 by Dr. Charles R. Severance
4. <https://docs.python.org/3/tutorial/>
<https://www.datacamp.com/community/tutorials/beginner-guide-google-vision-api>

- Unit 5 Image Restoration and Reconstruction [6 Lectures]**
5.1 A Model of the Image Degradation / Restoration Process, Noise Models
5.2 Restoration in the Presence of Noise Only Spatial Filtering
5.3 Periodic Noise Reduction by Frequency Domain Filtering
5.4 Band reject Filters: Band passFilters, Notch Filter
5.5 Estimating the Degradation Function
5.6 Inverse Filtering
5.7 Minimum Mean Square Error (Wiener) Filtering
Geometric Mean Filter
- Unit 6 Image Compression [5 Lectures]**
6.1 Some basic compression methods
6.2 Huffman Coding
6.3 Arithmetic Coding
- Unit 7 Morphological Image Processing [9 Lectures]**
7.1 Erosion and Dilation
7.2 Opening and Closing
7.3 Hit-or-Miss Transformation
7.4 Basic Morphological Algorithms
7.5 Boundary Extraction
7.6 Hole Filling, Extraction of Connected Components
7.7 Convex Hull, Thinning, Thickening, Skeletons, Pruning
7.8 Morphological Reconstruction
7.9 Introduction to Gray scale and Color Morphology
- Unit 8 Image Segmentation [6 Lectures]**
8.1 Point, Line, and Edge Detection: Background, Detection of Isolated Points
8.2 Line Detection, Edge Models, Basic Edge Detection
- Unit 9 Representation and Description [6 Lectures]**
9.1 Representation
9.2 Boundary Descriptors
9.3 Regional Descriptors
9.4 Texture

Reference Books:

- 1) Gonzalez, R. C. and Woods, R. E. [2002 / 2008], Digital Image Processing, 3rd ed., PrenticeHall
 - 2) Sonka, M., Hlavac, V., Boyle, R. [1999]. Image Processing, Analysis and Machine Vision (2nd edition), PWS Publishing, or (3rd edition) Thompson Engineering, 2007
 - 3) Gonzalez, R. C., Woods, R. E., and Eddins, S. L. [2009]. Digital Image Processing Using MATLAB, 2nd edition, Gatesmark Publishing, Knoxville, TN.
 - 4) Anil K. Jain [2001], Fundamentals of digital image processing (2nd edition), Prentice-Hall, NJ.
 - 5) William K. Pratt [2001], Digital Image Processing (3rd Edition), John Wiley & Sons, NY.
 - 6) Burger, Wilhelm and Burge, Mark J. [2008]. Digital Image Processing
 - 7) Kropatsch, Digital Image Analysis (With CD-ROM), Springer, ISBN: 978038795066
- Jähne, Digital Image Processing, 6e (With CD), Springer, ISBN: 978-3-540-24035-82

SEM V

MIM 505 LAB WORK

SEM V

MIM 506 Cryptography And Network Security

Unit 1

[15 Lectures]

- 1.1Advanced TCP/IP TCP Services,
- 1.2TCP format and connection management,
- 1.3Encapsulation in IP, UDP Services,
- 1.4Format and Encapsulation in IP, IP Services,
- 1.5 Header format and addressing,
- 1.6 Fragmentation and reassembly,
- 1.7 Migration to IPv6,
- 1.8Protocols: BOOTP, DHCP, ICMP, IGMP;
- 1.9Internet Routing Protocols: OSPF, RIP, EIGRP, BGP.

Unit 2

[15 Lectures]

- 2.1High Speed Networks Packet Switching Networks;
- 2.2Frame Relay Networks;
- 2.3Asynchronous Transfer Mode (ATM);
- 2.4ATM protocol Architecture; ATM logical connections;
- 2.5ATM cells; ATM Service categories;
- 2.6 ATM Adaptation Layer;
- 2.7QoS in ATM and Frame Relay

Unit 3

[5 Lectures]

- 3.1 High Speed LANs LAN Ethernet
- 3.2fast Ethernet
- 3.3gigabit Ethernet
- 3.4FDDI, DSL, ADSL

Unit 4

[10 Lectures]

- 4.1Wireless communication Wireless networks
- 4.2 wireless channels, channel access
- 4.3 network architecture

- 4.4 IEEE 802.11
- 4.5 Bluetooth
- 4.6 Satellite Networks.

Unit 5

[15 Lectures]

- 5.1 Network Security and Management Principles of cryptography
- 5.2 Authentication, integrity
- 5.3 key distribution and certification
- 5.4 Access control and Firewalls, attacks and counter measures, security in many layers.
- 5.5 Infrastructure for network management
- 5.6 The internet standard management framework
- 5.7 SMI, MIB, SNMP
- 5.8 Security and administration

References:

- Computer networks: Tanenbaum, Andrew S, Prentice Hall
- Data communication & networking: Forouzan, B. A. Computer network protocol standard and interface Uyles, Black

SEM V

MIM 507 Internet Of Things

UNIT 1 Introduction [13 Lectures]

- 1.1 What is the Internet of Things? : History of IoT, About IoT, Overview and Motivations,
- 1.2 Examples of Applications,
- 1.3 Internet of Things Definitions and Frameworks : IoT Definitions, IoT Architecture, General Observations
- 1.4 ITU-T Views, Working Definition
- 1.5 IoT Frameworks,
- 1.6 Basic Nodal Capabilities

UNIT 2 Fundamental Iot Mechanisms And Key Technologies [12 Lectures]

- 2.1 Identification of IoT Objects and Services
- 2.2 Structural Aspects of the IoT
- 2.3 Environment Characteristics
- 2.4 Traffic Characteristics
- 2.5 Scalability, Interoperability
- 2.6 Security and Privacy, Open Architecture
- 2.7 Key IoT Technologies
- 2.8 Device Intelligence
- 2.9 Communication Capabilities
- 2.10 Mobility Support, Device Power, Sensor Technology, RFID Technology Satellite Technology

UNIT 3 Radio Frequency Identification Technology [15 Lectures]

- 3.1 RFID: Introduction, Principle of RFID
- 3.2 Components of an RFID system
- 3.3 Issues EPC Global Architecture Framework: EPCIS & ONS Design issues, Technological challenges, Security challenges
- 3.4 IP for IoT, Web of Things.
- 3.5 Wireless Sensor Networks: History and context
- 3.6 WSN Architecture, the node, Connecting nodes, Networking Nodes
- 3.7 Securing Communication WSN specific IoT applications, challenges: Security, QoS, Configuration, Various integration approaches,
- 3.8 Data link layer protocols, routing protocols and infrastructure establishment.

UNIT 4 Resource Management In The Internet Of Things

[12 Lectures]

- 4.1 Clustering, Software Agents
- 4.2 Clustering Principles in an Internet of Things Architecture,
- 4.3 Design Guidelines, and Software Agents for Object Representation,
Data Synchronization.
- 4.4 Identity portrayal, Identity management, various identity management models: Local, Network, Federated and global web identity
- 4.5 User-centric identity management, device centric identity management and hybrid-identity management
- 4.6 Identity and trust.

UNIT 5 Internet of Things Application

[8 Lectures]

- 5.1 Smart Metering Advanced Metering Infrastructure
- 5.2 e-Health Body Area Networks
- 5.3 City Automation
- 5.4 Automotive Applications
- 5.5 Home Automation
- 5.6 Smart Cards

References:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Wiley Publications
2. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
3. Parikshit N. Mahalle & Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).

SEM VI

MIM 601 : Industrial Project /Institutional project

Total Credits : 20

Workload :

1. One mentor to be assigned for 5 students.
2. 2 hours /week to be allotted for 5 students

Guidelines:

1. Each student must individually complete minimum 5 months full time Industrial Project / Institutional project in the 6th semester, It is equivalent to 5 theory courses of 4 credits each.
2. Marks per 4 credits = 100. The total weight age for Industrial/Institutional Project is 500 marks.
3. College should assign a mentor to every student. The mentor will monitor the progress of the student throughout the semester for continuous assessment.
4. Student should submit a valid offer letter at the start of the internship. There will be continuous assessment of the work done by the student during the internship period.

Continuous assessment guidelines:

1. Student should submit a weekly report in the college to the mentor.
2. The report should contain the following details: Name of student, project title, company name, company mentor, daily activities and results/output, proposed work for next week.
3. The weekly report should be duly signed by the student and company mentor/ institute guide (CM).
4. Student Mentor should maintain weekly attendance record for every student.

5. Two presentations should be conducted for each student (first presentation after first month and second presentation after 3rd month)

6. Student Mentor should take feedback from the Company mentor regarding overall performance of the student. At the end of the internship period, each student should prepare a report.

Examination and Evaluation guidelines:

The project done during internship period will be evaluated in the following manner:

Internal evaluation : 150 Marks

External evaluation:350 Marks

The final presentation and documentation will be evaluated by three examiners:

1. Student mentor (appointed by respective college)
2. External examiner (appointed by the University)
3. IT expert (appointed by respective college)

Internal Evaluation(150 Marks)				
Weekly attendance	Weekly reports	First Presentation	Second Presentation	Documentation
20	40	20	40	30
External Evaluation(350 Marks)				
Mentor		IT Expert		External Examiner
100		125		125

