Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

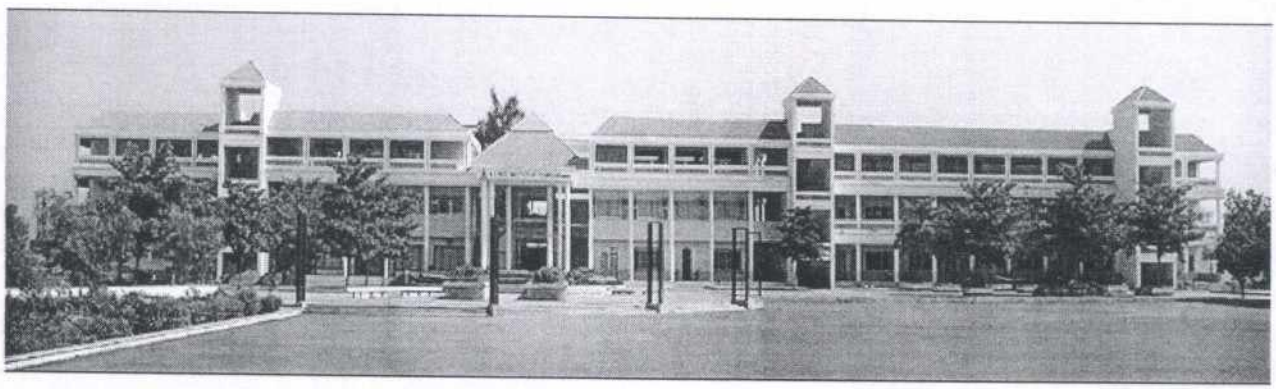
(An Autonomous Institute)

Course Structure and Syllabus

Honors Program in Intelligent Computing

Computer Engineering

With effect from Year 2025-26



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Honors Program in Intelligent Computing offered by Computer Engineering (w.e.f. 2025-26)

Sr. No.	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
Sem-III														
1	H1	RCP23CH2201	Soft Computing	3			25	15	15	15	60	100	3	3
Sem-IV														
2	H1	RCP23CH2251	Optimization Techniques	3			25	15	15	15	60	100	3	4
	H1	RCP23CH2251L	Optimization Techniques Laboratory			2	25				25	50	1	
Sem-V														
3	H1	RCP23CH2301	Ubiquitous Computing	3			25	15	15	15	60	100	3	4
	H1	RCP23CH2301L	Ubiquitous Computing Laboratory			2	25				25	50	1	
Sem-VI														
4	H1	RCP23CH2351	Intelligent Security Systems	3			25	15	15	15	60	100	3	3
Sem-VII														
5	H1	RCP23CH2401	Bayesian Computing	3			25	15	15	15	60	100	3	4
	H1	RCP23CH2401L	Bayesian Computing Laboratory			2	25				25	50	1	
			Total	15		6	200			75	375	650	18	

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R. C. Patel Institute of Technology
Autonomous

Program: Computer Engineering	S.Y. B.Tech.	Semester: III
Soft Computing (RCP23CH2201)		

Prerequisites: Basic Mathematics, Neural Network basics, Fuzzy sets and Fuzzy Logic basic.

Course Objective(s):

1. To become familiarized with advanced Neural network.
2. To be able to design Fuzzy Inference systems and familiarized with Fuzzy Rough set theory and hybrid systems.
3. To become familiarized with learning, associative memories and adaptive resonance theory.
4. To become familiarized with applications of advanced soft computing.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the constituents and characteristics of soft computing.	L2	Understand
CO2	Design fuzzy logic controller for various systems.	L6	Create
CO3	Design neural networks for applications using supervised and unsupervised learning.	L6	Create
CO4	Understand and apply hybrid systems to real world problems.	L3	Apply

Soft Computing (RCP23CH2201)
Course Contents

Unit-I — 05 Hrs.

Introduction: Introduction to soft Computing: Fuzzy Computing, Neural Computing, Associative Memory, Adaptive Resonance Theory, applications.

Unit-II — 10 Hrs.

Fuzzy Systems: Fuzzy sets, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference systems.

Fuzzy Controller: Table based controller, Mamdani fuzzy controller, Takagi-Sugeno controller.

Rough Set theory: Concept of Discernibility, Vagueness in Rough Sets, Uncertainty in Rough Sets, Introduction to type-2 fuzzy sets

Unit-III — 12 Hrs.

Neural Network:

Fundamentals of Neural Networks: Types of Learning, Linear Separability, Learning rules

Supervised Learning: SDPTA, SCPTA, MCPTA, Error Back propagation training algorithm

Unsupervised Learning: Self-Organizing Maps, Learning Vector Quantization, Radial Basis Function Networks

Unit-IV — 08 Hrs.

Pattern Association:

Associative Memory Network: Description, Auto- associative Memory, Bidirectional Associative memory, Hetero-associative memory.

Adaptive Resonance Theory: Stability Plasticity Dilemma, ART Networks, ART1

Unit-V — 04 Hrs.

Hybrid system: Neuro Fuzzy hybrid systems: ANFIS, CANFIS, Fuzzy Associative Memories, simplified Fuzzy ARTMAP

Text Books:

1. Jacek M. Zurada, "Introduction to Artificial Neural Systems", West Publication.
2. J.S.R Jang, C.T. Sun and E. Mizutani, "Neuro-Fuzzy and Soft Computing", PHI.
3. Laurene Fausett, "Fundamentals of Neural Networks", Pearson.
4. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Wiley, 2nd Edition.

Reference Books:

1. Satish Kumar, "Neural Networks A Classroom Approach", McGrawHill, 2nd Edition.
2. Kishan Mehrotra, Chilukuri K. Mohan, Sanjay Ranka, "Elements of Artificial Neural Networks", 2nd Edition, PRI.

Program: Computer Engineering	S.Y. B.Tech.	Semester: IV
Optimization Techniques (RCP23CH2251)		
Optimization Techniques Laboratory (RCP23CH2251L)		

Prerequisites:

1. Basic Database Concepts.
2. Concepts of algorithm design and analysis.

Course Objective(s):

1. Introduce students to the principles and applications of bio-inspired optimization techniques.
2. Develop understanding of evolutionary algorithms, swarm intelligence, and ant colony optimization.
3. Build proficiency in implementing and analyzing various natural computing approaches.
4. Enable students to apply optimization techniques to solve real-world engineering problems.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply genetic algorithms, particle swarm optimization, and ant colony optimization to solve complex optimization problems.	L3	Apply
CO2	Evaluate and select appropriate optimization algorithms based on problem characteristics.	L5	Evaluate
CO3	Implement bio-inspired algorithms using appropriate programming tools and frameworks.	L6	Create
CO4	Analyze optimization results and performance metrics to improve algorithm efficiency.	L4	Analyze

Optimization Techniques (RCP23CH2251)
Course Contents

Unit-I — 05 Hrs.

Introduction to Natural Computing

From nature to natural computing, sample idea, Philosophy of natural computing, Natural computing approaches, Natural Phenomena, Models, and Metaphors, From Nature to Computing and Back Again, General Concepts – Individuals, Entities, Agents; Parallelism and Distributivity; Interactivity; Adaptation; Feedback; Self- Organization; Bottom-Up Vs Top-Down.

Unit-II — 08 Hrs.

Evolutionary Computing – Genetic Algorithms

Basic Principles of Genetics, Fitness Function; Selection: Selective Pressure, Random Selection, Proportional Selection, Tournament Selection, Rank-Based Selection, Boltzmann Selection, Elitism; Reproduction Operators: Crossover operator, Mutation; Application: Pattern Recognition, Numerical Function Optimization.

Unit-III — 08 Hrs.

Swarm Intelligence: Particle Swarm Optimization: Basic Particle Swarm Optimization: Global Best PSO, Local Best PSO, Velocity Components; Basic PSO parameters, Single Solution Particle Swarm Optimization: Guaranteed Convergence PSO, Social- Based Particle Swarm Optimization, Hybrid Algorithms, Sub-Swarm Based PSO, Multi-Start PSO Algorithms, Repelling Methods, Binary PSO; Application.

Unit-IV — 06 Hrs.

Ant Algorithm: Simple Ant Colony Optimization, Ant Colony Optimization Meta-Heuristic, Cemetery Organization and Brood Care, Division of Labor, Application: Travelling Salesman Problem.

Unit-V — 06 Hrs.

Advanced Bio-inspired Optimization Techniques: Artificial Bee Colony (ABC) Algorithm - based on foraging behavior of honey bees, Firefly Algorithm - inspired by the flashing behavior of fireflies, Cuckoo Search - based on brood parasitism of cuckoo species, Bacterial Foraging Optimization - inspired by bacteria seeking nutrients.

Unit-VI — 06 Hrs.

Hybrid Optimization and Applications in Data Analysis: Memetic Algorithms - combining population-based methods with local search. Multi-objective Optimization - techniques for problems

with competing objectives, Self-adaptive Parameter Control - advanced methods for algorithm tuning, Parallel and Distributed Optimization - scaling up optimization approaches, Applications in Data Science - practical uses in classification, clustering, feature selection, etc.

Optimization Techniques Laboratory (RCP23CH2251L)

List of Laboratory Experiments

Suggested Experiments:(Any 8)

1. Implementation of different selection methods in Genetic Algorithms and performance comparison
2. Solving the Traveling Salesman Problem using Genetic Algorithms with different crossover and mutation operators
3. Implementation of Particle Swarm Optimization for benchmark function optimization
4. Comparison of Global Best PSO and Local Best PSO on multimodal functions
5. Implementation of Ant Colony Optimization for path finding and route optimization
6. Solving resource allocation problems using Ant Colony Optimization
7. Implementation of Artificial Bee Colony algorithm for continuous function optimization
8. Application of Firefly Algorithm for feature selection in classification problems
9. Implementation of Cuckoo Search for constrained optimization problems
10. Comparison of multiple bio-inspired algorithms on a standard benchmark suite
11. Development of a hybrid optimization algorithm combining two bio-inspired techniques
12. Optimization of machine learning model hyperparameters using bio-inspired techniques

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. X. S. Yang, "Nature-Inspired Optimization Algorithms", 2nd Edition, Elsevier, 2021.
2. A. P. Engelbrecht, "Computational Intelligence: An Introduction", 3rd Edition, Wiley, 2022.

3. A. E. Eiben and J. E. Smith, "Introduction to Evolutionary Computing", 3rd Edition, Springer, 2023.

4. T. Weise, "Global Optimization Algorithms – Theory and Application", 3rd Edition, Self-Published, 2021.

Reference Books:

1. M. Dorigo and T. Stützle, "Ant Colony Optimization: Principles, Applications, and Extensions", 2nd Edition, MIT Press, 2022.

2. D. Karaboga and B. Akay, "Artificial Bee Colony Algorithm and Its Applications", Springer, 2021.

3. R. V. Rao, "Teaching Learning Based Optimization Algorithm: And Its Engineering Applications", Springer, 2022.

4. C. A. Coello Coello, G. B. Lamont, and D. A. Van Veldhuizen, "Evolutionary Algorithms for Solving Multi-Objective Problems", 3rd Edition, Springer, 2023.

5. D. Simon, "Evolutionary Optimization Algorithms: Biologically Inspired and Population-Based Approaches to Computer Intelligence", 2nd Edition, Wiley, 2023.

Program: Computer Engineering	T.Y. B.Tech.	Semester: V
Ubiquitous Computing (RCP23CH2301)		
Ubiquitous Computing Laboratory (RCP23CH2301L)		

Prerequisite: Knowledge of Computer Networks.

Course Objective(s):

1. To understand characteristics of Ubiquitous Computing.
2. To understand the trends, strengths and weaknesses of systems in a ubiquitous environment.
3. To understand human interaction behavior with ubiquitous systems.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe the characteristics of Ubiquitous computing.	L2	Understand
CO2	Analyze the strength and limitations of the current tools, devices and communications.	L4	Analyze
CO3	Identify human interaction behavior with systems in a ubiquitous environment.	L1	Remember
CO4	Explore the trends and problems of current ubiquitous computing systems.	L3	Apply

Ubiquitous Computing (RCP23CH2301)
Course Contents

Unit-I — 06 Hrs.

Introduction to Ubiquitous Computing: :

Impact of digital world, Illustrative applications, Modelling the Key Ubiquitous Computing Properties, Ubiquitous System Environment Interaction, Architectural Design for Ubiquitous Computing Systems.

Unit-II — 07 Hrs.

Smart Devices and Services: : Service Architecture Models, Service Provision Life-Cycle, Smart Mobile Devices, Smart Card Devices.

Unit-III — 07 Hrs.

Human–Computer Interaction: User Interfaces and Interaction for Widely Used Devices, Hidden UI Via Basic Smart Devices .

Unit-IV — 07 Hrs.

Context-Aware Systems: Modeling Context-Aware Systems, Mobility Awareness, Spatial Awareness.

Unit-V — 06 Hrs.

Management of Smart Devices: Managing Smart Devices in Virtual Environments, Managing Smart Devices in Human User-Centred Environments, Managing Smart Devices in Physical Environments.

Unit-VI — 06 Hrs.

Challenges and Outlook: Overview of challenges, smart devices, Smart Interaction, Smart physical environment device interaction, Smart human-device interaction, Human Intelligence versus machine intelligence, social issues.

Ubiquitous Computing Laboratory (RCP23CH2301L)

List of Laboratory Experiments

Suggested Experiments:

1. Applications for location-based messages.
2. Context-Aware system.
3. Human Computer Interaction.
4. Ubiquitous Communication .
5. Case study of Class Room 2030.
6. Case study of Super Market.
7. Case study of Hospital Management.
8. Case study on evolution of smart devices.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. Stefan Poslad, "Ubiquitous Computing, Smart Devices, Environment and Interaction," Wiley.
2. John Krumm, "Ubiquitous Computing Fundamentals," CRC Press.

Reference Books:

1. Adam Greenfield, "Everyware: The Dawning Age of Ubiquitous Computing," Pearson Education.
2. Genco and Sorce, "Pervasive Systems and Ubiquitous Computing," WIT Press, 1st Edition, 2010.

Program: Computer Engineering	T.Y. B.Tech.	Semester: VI
Intelligent Security Systems (RCP23CH2351)		

Prerequisites: Basic knowledge of Computer Networks,Basic knowledge of Databases and Operating Systems.

Course Objective(s):

1. To better understand how to apply artificial intelligence, machine learning, and data science in the computer security domain.
2. Introduce readers into the current state of an application of intelligent methodologies in computer security and information assurance systems design.
3. To get better prepared either to enter the workforce or to upgrade their skills.
4. Gain knowledge in the most trending area of the current computer science and will be able to employ it in solving cybersecurity problems.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Gain the knowledge and skills at the intersection of computer security and artificial intelligence, machine learning, and data science domain.	L2	Understand
CO2	Upgrade their skills and better understand intelligent techniques.	L3	Apply
CO3	Apply their knowledge and skills in computer security domain.	L3	Apply

Intelligent Security Systems (RCP23CH2351)
Course Contents

Unit-I — 06 Hrs.

Current Computer Security Landscape:

- The Current Security Landscape,
- Computer Security Basic Concepts,
- Sources of Security Threats,
- Attacks Against IoT and Wireless Sensor Networks,
- Introduction to Artificial Intelligence, Machine Learning and Data Science,
- Fuzzy Logic and Systems,
- Machine Learning,
- Artificial Neural Networks (ANN),
- Genetic Algorithms (GA),
- Hybrid Intelligent Systems

Unit-II — 07 Hrs.

Firewall Design and Implementation:

- Firewall Definition, History, and Functions
- Firewall Operational Models, Basic Firewall Architectures
- Process of Firewall Design
- Implementation and Maintenance
- Firewall Policy Formalization with Rules
- Firewalls Evaluation and Current Trends

Unit-III — 07 Hrs.

Intrusion Detection Systems:

- Definition, Goals, and Primary Functions
- IDS from a Historical Perspective
- Typical IDS Architecture Topologies

- Components and Operational Ranges
- IDS Types: Classification Approaches
- IDS Performance Evaluation
- Artificial Intelligence and Machine Learning Techniques in IDS Design
- Intrusion Detection Challenges and Their Mitigation in IDS Design and Deployment Intrusion Detection Tools

Unit-IV 07 Hrs.

Anti Malware Systems:

- Malware Definition, History, and Trends in Development
- Malware Classification
- Spam
- Software Vulnerabilities
- Principles of Malware Detection and Anti-malware Protection
- Malware Detection Algorithms
- Anti-malware Tools

Unit-V 06 Hrs.

Hackers and Ethical Users:

- Hacker's Activities and Protection Against Them
- Data Science Investigation of Ordinary Users' Practice
- User Authentication
- User Anonymity
- Attacks Against Anonymity and Protection Measures

Unit-VI 06 Hrs.

Adversarial Machine Learning:

- Adversarial Machine Learning Definition
- Adversarial Attack Taxonomy
- Defense Strategies
- Investigation of the Adversarial Attacks' Influence on Classifier Performance (Use Case)

- Generative Adversarial Networks (GANs)
- Adversarial Autoencoders

Text Books:

1. Leon Reznik, "Intelligent Security Systems: How Artificial Intelligence, Machine Learning and Data Science Work for and Against Computer Security", 1st Edition, Wiley, 2021.

Reference Books:

1. David Foster, "Generative Deep Learning: Teaching Machines to Paint, Write, Compose and Play", O'Reilly, 1st Edition, 2021.
2. Rowel Atienza, "Advanced Deep Learning with Keras", Packt Publishing, 1st Edition, 2018.
3. Kerry J. Cox and Christopher Gerg, "Managing Security with Snort & IDS Tools", O'Reilly Media, Inc., 2004.
4. J. Michael Stewart, "Network Security, Firewalls and VPNs", Jones and Bartlett Publishers, 2nd Edition, July 2013.

Program: Computer Engineering	Final Year B.Tech.	Semester: VII
Bayesian Computing (RCP23CH2401)		
Bayesian Computing Laboratory (RCP23CH2401L)		

Prerequisites: Mathematics and statistics and R/Python Programming

Course Objective(s):

1. To introduces the Bayesian approach to statistical inference for data analysis in a variety of applications.
2. To identify different types of priors, the use of the posterior distribution to perform different types of inferences using predictive distribution.
3. To introduce the fundamental ideas of Markov chain Monte Carlo (MCMC) methods that provides a reasonable approximation to the posterior distribution of interest.
4. To introduces the use of exchangeable models in a wide variety of modelling and application areas from a Bayesian viewpoint.
5. To apply the Bayesian models in regression modelling, Gibbs sampling.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Draw an inference from computing models and make use of posterior probability distribution over a set of hypotheses or models.	L3	Apply
CO2	Provide new methodologies in the transmission of statistical ideas to assess robustness of inferences in particular applications.	L3	Apply

Bayesian Computing (RCP23CH2401)
Course Contents

Unit-I — 06 Hrs.

Introduction to Bayesian Thinking: Introduction, Learning About the Proportion of Heavy Sleepers, using a Discrete Prior, using a Beta Prior, Using a Histogram Prior, Prediction, Single-Parameter Models: Introduction, Normal Distribution with Known Mean but Unknown Variance, Estimating a Heart Transplant Mortality Rate, Bayesian Robustness, Mixtures of Conjugate Priors, A Bayesian Test of the Fairness of a Coin, Multiparameter Models: Introduction, Normal Data with Both Parameters Unknown, A Multinomial Model, A Bioassay Experiment, Comparing Two Proportions.

Unit-II — 07 Hrs.

Bayesian Computation: Introduction, Computing Integrals, Setting Up a Problem, A Beta-Binomial Model for Over dispersion, Approximations Based on Posterior Modes, The Example, Monte Carlo Method for Computing Integrals, Rejection Sampling, Importance Sampling, Sampling Importance Resampling.

Unit-III — 07 Hrs.

Markov Chain Monte Carlo Methods: Introduction, Introduction to Discrete Markov Chains, Metropolis-Hastings Algorithms, Gibbs Sampling, MCMC Output Analysis, A Strategy in Bayesian Computing, Learning About a Normal Population from Grouped Data, Example of Output Analysis, Modeling Data with Cauchy Errors, Analysis of the Stanford Heart Transplant Data.

Unit-IV — 07 Hrs.

Hierarchical Modeling: Introduction, Three Examples, Individual and Combined Estimates, Equal Mortality Rates? Modeling a Prior Belief of Exchangeability, Posterior Distribution, Simulating from the Posterior, Posterior Inferences, Bayesian Sensitivity Analysis, Posterior Predictive Model Checking, Model Comparison: Introduction, Comparison of Hypotheses, A One-Sided Test of a Normal Mean, A Two-Sided Test of a Normal Mean, Comparing Two Models, Models for Soccer Goals, A Test of Independence in a Two-Way Contingency Table.

Unit-V — 06 Hrs.

Regression Models: Introduction, Normal Linear Regression: The Model, The Posterior Distribution, Prediction of Future Observations, Computation, Model Checking, An Example. Model Selection Using Zellner's g Prior. Survival Modeling.

Unit-VI 06 Hrs.

Gibbs Sampling: Introduction, Robust Modeling, Binary Response Regression with a Probit Link: Missing Data and Gibbs Sampling, Proper Priors and Model Selection, Estimating a Table of Means: A Flat Prior Over the Restricted Space, A Hierarchical Regression Prior, Predicting the Success of Future Students.

Bayesian Computing Laboratory (RCP23CH2401L)

List of Laboratory Experiments

Suggested Experiments:(Any 10)

1. Exploring student's dataset for
    1. What is your gender?
    2. What is your height in inches?
    3. Choose a whole number between 1 and 10.
    4. Give the time you went to bed last night.
    5. Give the time you woke up this morning.
    6. What was the cost (in dollars) of your last haircut, including the tip?
    7. Do you prefer water, pop, or milk with your evening meal?
2. Implement a Discrete Prior, Beta Prior, Histogram Prior, Prediction model using R.
3. Implement a model for Estimating a Heart Transplant Mortality Rate using R.
4. Implement a model for A Bioassay Experiment: consider data from Gelman et al. (2003), where one observes a dose level (in log g/ml), the number of animals, and the number of deaths for each of four groups.
5. Implement a Logistic Modeling A math department is interested in exploring the relationship between students' scores on the ACT test, a standard college entrance exam, and their success (getting an A or a B) in a business calculus class. Data were obtained for a sample of students.
6. Implement a Beta-Binomial Model for Over dispersion using Cancer mortality data.
7. Estimation for the two-parameter exponential distribution: Using your simulated values from the posterior, find the posterior mean and posterior standard deviation.
8. Implement a Learning About a Normal Population from Grouped Data, using height and frequency data from student's dataset.
9. Implement a model for Analysis of the Stanford Heart Transplant Data.
10. Implement a model to test of Independence in a Two-Way Contingency Table.

11. Study of R to Interface with WinBUGS, a stand-alone software program for the Windows operating system.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. Jim Albert, "Bayesian Computation with R", 2nd Edition, Springer, 2009.
2. Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin, "Bayesian Data Analysis", 3rd Edition, CRC Press/Taylor & Francis, 2013.

Reference Books:

1. Peter Congdon, "Bayesian Statistical Modelling", 2nd Edition, Wiley Publications, ISBN-13: 978-0-470-01875-0 (HB).

Web References:

1. https://www.math.wustl.edu/ nlin/math459.
2. Bayesian Statistics — Coursera