Detailed Syllabus
Lecture-wise Breakup

Subject Code	17M11CS122	**Semester:** Even **(specify Odd/Even)**	**Semester** II **Session** 2020-2021 **Month from** Jan'21 **to** June'21
Subject Name	Performance Evaluation of Computing Systems		
Credits	3	**Contact Hours**	3-0-0

Faculty (Names)	**Coordinator(s)**	Dr.Kavita Pandey
	Teacher(s) (Alphabetically)	Dr. Kavita Pandey

COURSE OUTCOMES		**COGNITIVE LEVELS**
C114.1	Demonstrate the ability to describe the correct tools and techniques for computer system performance evaluation	Understand (level 2)
C114.2	Identify the probability distribution in a given stream of data that corresponds to a source of randomness in a system.	Apply (level 3)
C114.3	Design the appropriate model of a discrete, dynamic, stochastic system using the theory of random processes.	Apply (level 3)
C114.4	Inspect the mathematical modeling techniques, Markov chains, queuing theory for analyzing the system.	Analyze (level 4)
C114.5	Select the appropriate experiments and perform a simulation study of the given system.	Evaluate (level 5)

Module No.	**Title of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Overview of Performance Evaluation	Need for Performance Evaluation, Systematic approach to Performance Evaluation, Selection of evaluation techniques and performance metrics	5
2.	Random Variables and Probability distributions	Discrete and continuous random variable, Expectation and variance, Bernoulli random variable, Binomial distribution, Poisson distribution, Geometric distribution, Normal and Exponential distribution, Normal approximation and Poisson approximation to binomial distribution, hazard rate function, , Comparing systems using sample data, Confidence interval	10
3.	Markov Process	Introduction and classification of stochastic processes, Discrete time and Continuous time markov chains, Birth and death processes , Transition probabilities, Steady state solution, Performance measure in	6

		terms of time spent and expected reward	
4.	Queuing models	Basics of Queuing theory, Kendall notation, Little's Law, Analysis of a single queue with one server and multiple servers, Analysis of finite buffers queuing systems	8
5.	Simulation modeling	Introduction to simulation, Types of simulation, Random number generation, a survey of random number generators, seed selection, testing random number generators , random variate generation	6
6.	Measurement techniques and tools	The art of data presentation, Ratio Games	2
7.	Experimental design and analysis	Types of Experimental designs, 2^2 factorial designs, General 2^K factorial designs, 2^{K-p} fractional factorial designs	5
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Attendance (10 Marks), Assignments / Quiz / Mini project (15 Marks)
Total	**100**

Project based Learning: Each student in a group of 2-3, study the research papers related to experimental designs. To make it application based, students select the recent articles which is applied on various contemporary domains. Understanding the research papers gives them the knowledge about applicability of experimental designs in identifying the important factors, their variations, etc.

RecommendedText books:

1.	Raj Jain, "The Art of Computer Systems PerformanceAnalysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling", Wiley, Reprint Edition, © 2014.
2.	K.S. Trivedi, "Probability and Statistics with Reliability,Queueing and Computer Science Applications", JohnWiley and Sons, 2nd Edition, Reprint Edition, © 2018.

RecommendedReference books:

1.	Ross, Sheldon M. "A First Course in Probability". Upper Saddle River, N.J.: Pearson Prentice Hall, 10th Edition, ©2019
2.	Obaidat, Boudriga, "*Fundamentals of Performance Evaluation of Computer and Telecommunication Systems* ", 2010, Wiley, ISBN 978-0-471-26983
3.	Ross, Sheldon M. "Introduction to Probability Models". Amsterdam: Academic Press, 12th Edition, ©2019
4.	Fortier, Michel, "Computer Systems Performance Evaluation and Prediction", 2003, Elsevier, ISBN 1-55558-260-5

Detailed Syllabus

Subject Code	17M22CS115	**Semester Even**	**Semester M.Tech II** **Session 2020- 2021** **Month from Jan to June**
Subject Name	Large Scale Graph Algorithms and Analytics		
Credits	**3**	**Contact Hours**	**3**
Faculty (Names)	**Coordinator(s)**	Dr. Adwitiya Sinha	
	Teacher(s) (Alphabetically)	Dr. Adwitiya Sinha	

S.No.	Description	Cognitive Level (Blooms Taxonomy)
C161.1	Understand the characteristics & significance of large-scale graphs over complex structures	Understanding Level (Level III)
C161.2	Analyze several techniques to yield and process information from large-scale real-world data sources	Analyzing Level (Level II)
C161.3	Apply the concept of random network theory to large graphs	Applying Level (Level IV)
C161.4	Evaluate the heterogeneous behavior in large-scale graphs with hyper-graphs and multi-graphs for recommendation	Evaluating Level (Level V)
C161.5	Design algorithmic frameworks for large-scale complex interconnected structures	Creating Level (Level VI)

Module No.	Subtitle of the Module	Topics in the module	No. of Lectures for the module
1	Introduction to Large-scale Graphs	Basics of Graph, Multi-Graph, Hypergraph & its Duality, Introduction & Application of Large-scale Graph, Characteristics, Challenges	6
2	Data Sources & Categorization	Complex Data Sources (Social Networks, Simulations, Bioinformatics), Categories – Social graphs (Facebook, Twitter, Google+), Endorsement graphs (Web Link Graph, Paper Citation Graph), Location graphs (Map, Power Grid, Telephone Network), Co-occurrence Graphs (Term-Document Bipartite, Click-through Bipartite)	7
3	Basic Large-scale Graph Analysis	Basic Large-scale Graph Analysis (Efficient Search – Graph Traversal and Search Algorithms; Pattern Discovery -Matching Algorithms, Centrality Computing Algorithms, List Ranking Algorithms; Partitioning – Connected Component Algorithms, Graph-Cut Algorithms)	7

4	Advanced Large-scale Graph Analysis	Advanced Large-scale Graph Analysis (Graph indexing and ranking – Link Analysis Algorithms, Web Crawling, Page Ranking Personalized Page Rank, Page Rank Axioms, HITS; Data Based Approaches – Clustering and Classification Algorithms	7
5	Computation for Massive Data Sets	Large scale Graph Clustering: Spectral Clustering, Modularity-based Clustering, Random Walks, Social Balance Theory	5
6	Large Graph Representation, Analysis &Implementation	Adjacency Matrix Representation, Adjacency List Representation,Graph Implementation Strategies & Softwares (PowerBI, Python, NetworkX, Pajek, MapReduce, GraphLab, Orange)	5
7	Advanced Research Topics	Power Law Distribution in Social Networks, Models of Power Law Random Graphs, Game-Theoretic Approach to Modeling Network Creation, Rank Aggregation and Voting Theory, Recommendation Systems	5
Total number of Lectures			**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	Attendance (15 Marks), Assignment/Quiz/Mini-project (10 Marks)
Total	**100**

Project based learning: Each student in a group of 3-4 will extract data from real-world domains using data streaming, web crawling, application programming interfaces (APIs), or from standard repositories that are globally recognized. For conducting application-based research, the students are encouraged to analyze social/political/financial/disease related data and generate underlying networked structure based on activity and topology.Analysing thereal-world data for providing link prediction, community detection, security enhancements, commercial decision making, cost-benefit analysis, etc. using network science algorithms, tools, and analytics.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Deo, Narsingh. *Graph theory with applications to engineering and computer science*. Courier Dover Publications, 2017.
2.	Gross, Jonathan L., and Jay Yellen, eds. *Handbook of graph theory*. CRC press, 2003.
3.	Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications, L. N. de Castro (2006), CRC Press.
4.	Bondy, John Adrian, and Uppaluri Siva Ramachandra Murty. *Graph theory with applications*. Vol. 290. London: Macmillan, 1976.
5.	West, Douglas Brent. *Introduction to graph theory*. Vol. 2. Upper Saddle River: Prentice hall, 2001.
6.	Bollobás, Béla. *Modern graph theory*. Vol. 184. Springer Science & Business Media, 2013.

Detailed Syllabus
Lab-wise Breakup

Course Code	17M15CS123	**Semester** Even **(Even)**	**Semester** 2 **Session** 2020 -2021 **Month from** Jan to June, 2021
Course Name	**IoT Systems Development Lab**		
Credits	1	**Contact Hours**	2 Hours

Faculty (Names)	**Coordinator(s)**	Dr Chetna Dabas
	Teacher(s) (Alphabetically)	Dr. Chetna Dabas

COURSE OUTCOMES		**COGNITIVE LEVELS**
C181.1	Explain Node-RED IDE platform for IoT application development and demonstrate I/O nodes, flows, third party palettes, import/export of flows in Node-RED.	Understand (level 2)
C181.2	Develop user defined functional nodes and deploy it in Node-Red.	Apply (level 3)
C181.3	Analyze various IoT Communication protocols using APIs with Arduino and Raspberry Pi along with sensors and actuators.	Analyze (level 4)
C181.4	Apply and evaluate the characteristics of different IoT devices.	Evaluate (level 5)
C181.5	Design and develop IoT based applications for various challenges and problems related to Sustainable Development, e.g., energy and waste management, water conservation, clean energy, improving public health, sustainable urbanization, smart agriculture etc.	Create (level 6)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Node-Red Installation and Use	Setup and Install Node.js and Node-RED as IDE platform for IoT application development.	CO1
2.		Demonstrate I/O nodes, flows, third party palettes, import/export of flows in Node-RED	CO1
3.		Develop Java Script based IoT applications using functional nodes , flows and dashboard on Node-RED platform	CO2
4.		Developing and implementation of user defined nodes for creating flows in Node-Red.	
5.	Study and use of Arduino and Raspberry Pi, sensors and actuators.	Study and interface of Arduino and Rasberry Pi with different types of sensors and actuators	CO2
6.		Creation of various IoT based applications using Arduino and Rasberry Pi	CO3, CO4
7.	Developing IoT based systems applications using Arduino and Raspberry Pi	Developing smart applications for various challenges and problems related to Sustainable Development, e.g., energy and waste management, water conservation, clean energy, improving public health, sustainable urbanization, smart agriculture etc.	CO5

Evaluation Criteria

Components	**Maximum Marks**
Lab Test# 1	20
Lab Test# 2	20
Attendance	15

IoT System Development PBA	30
Report of Project	15
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Internet of Things: Architecture and Design Principles, Raj Kamal, McGrawHill.
2	"Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti
3	https://nodered.org/docs/getting-started
4.	https://www.arduino.cc/en/Tutorial/HomePage
5.	https://www.raspberrypi.org/documentation/

Detailed Syllabus
Lab-wise Breakup

Course Code	**17M15CS122**	**Semester Even (specify Odd/Even)**	**Semester 2nd Session** 2020 -2021 **Month from Jan'21 to June'21**
Course Name	Performance Engineering Lab		
Credits	**2**	**Contact Hours**	2 hrs

Faculty (Names)	**Coordinator(s)**	Dr. Kavita Pandey
	Teacher(s) (Alphabetically)	Dr. Kavita Pandey

COURSE OUTCOMES		**COGNITIVE LEVELS**
C174.1	Experiment with GProf to calculate the performance and statistics of a program in terms of call counts and timing information of functions.	Apply (level 3)
C174.2	Compare the performance of different protocols by simulating various network scenarios in NS2 Simulator.	Analyze (level 4)
C174.3	Design wired and wireless networks in NS2 and analyze the simulation results using AWK and Python programming.	Apply (level 3)
C174.4	Examine the performance of M/M/1, M/D/1 and D/M/1 Queuing models in NS2.	Analyze (level 4)
C174.5	Utilize the Weka Tool for analyzing data file.	Apply (level 3)

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	GNU Profiler	Use the Gprof (GNU Profiler) to analyze the performance and statistics of a program	1
2.	Network Simulator	Introduction to Network simulator (NS2) and exploring it's utilities NAM, XGraph etc.	2
3.	Wired Network Simulation	1. Creation of Wired Network Scenarios 2. Exploring the various Traffic Applications with the nodes and introduction of wired Trace file 3. Wired Network Performance Analysis using AWK and Python	3
4.	Queuing Analysis	1. Simulation of various queues in NS2 and analyzing their performances on various performance metrics such as throughput, average delay and packet loss 2. Simulation of various queue Scheduling Algorithms	4
5.	Analysis of Wireless Routing Protocols	1. Creation of wireless network scenarios and simulation of various wireless routing protocols 2. Analysis of wireless trace file using AWK and Python	3
6.	Weka Tool	Performance analysis of data file using WEKA tool	5

Evaluation Criteria

Components	**Maximum Marks**
Evaluation-1:	10
Lab test-1 :	20
Lab test-2 :	20
Evaluation-2 :	15

Project:	20
Attendance:	15
Total	**100**

Project based Learning: Each student in a group of 3-4, study the research papers related to performance analysis. The article should be recent and it should be in relation with the subject contents.Understanding and implementing the research paper enhances their working experience towards studied tools and concepts.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	GPROF Tutorial – How to use Linux GNU GCC Profiling Tool
2.	Marc Greis' Tutorial for the UCB/LBNL/VINT Network Simulator "ns"
3.	Introduction to Network Simulator NS2 by TeerawatIssariyakul, EkramHossain
4.	An Introduction to the WEKA Data Mining System by Zdravko Markov
5.	https://www.cs.waikato.ac.nz/~ml/weka/
6.	nile.wpi.edu/NS/
7.	The ns Manual, https://www.isi.edu/nsnam/ns/doc/ns_doc.pdf

Detailed Syllabus

Project Based Learning I (17M17CS111**)**
M.Tech CSE II Semester
Lab-wise Breakup

Subject Code	17M17CS111	**Semester** **Even**	Semester _II __ Session 2020-21 Month: from Jan To June 2021
Subject Name	Project Based Learning I (17M17CS111) Open Source Software Development		
Credits	**2**	**Contact Hours**	**0-0-4**
Faculty (Names)	**Coordinator(s)**	Dr. Arpita Jadhav Bhatt	
	Teacher(s)	Dr. Anuja Arora, Dr. Arpita Jadhav Bhatt	

COURSE OUTCOMES: At the completion of the course, students will be able to

S.NO	DESCRIPTION	COGNITIVE LEVEL (BLOOMS TAXONOMY)
CS211.1	Conduct literature review to compare and contrast their project with existing work in the area and prepare a project proposal to be delivered to their peers and faculty members	Understanding Level (Level II)
CS211.2	Develop an ability to function in task oriented team, divide role responsibilities to build a project on open data	Understanding Level (Level III)
CS211.3	Understand professional and ethical responsibility & acquire ability to communicate effectively amongst team members, peers & evaluators	Analyzing Level (Level II)
CS211.4	Analyze and identify various open data frameworks, RESTful APIs, Python libraries for project implementation; plan & submit project development timeline	Applying Level (Level IV)
CS211.5	Appraise by giving milestone presentations to their peers and faculty about their current progress.	Evaluating Level (Level V)
CS211.6	Prepare technical report detailing the problem statement, proposed methodology, software specification, design, test plan, and implementation details.	Creating Level (Level VI)

Course Description:

Module No.	**Subtitle of the Module**	**Topics in the module**	**CO**
1.	Conduct literature review	Conduct literature review to compare and contrast their project with existing work in the area and prepare a project proposal to be delivered to their peers and faculty members	CO1
2.	Role Mapping	Develop an ability to function in task oriented team, divide role	CO2

		responsibilities to build a project on open data	
3.	Coordination	Understand professional and ethical responsibility & acquire ability to communicate effectively amongst team members, peers & evaluators	CO3
4.	Submit Project Development Timeline	Analyze and identify various open data frameworks, RESTful APIs, Python libraries for project implementation; plan & submit project development timeline	CO4
5.	Presentation	Appraise by giving milestone presentations to their peers and faculty about their current progress.	CO4
6.	Prepare technical report	Prepare technical report detailing the problem statement, proposed methodology, software specification, design, test plan, and implementation details.	CO5

Project based learning: Project is an integral part of the lab. Students form a group (of size 3-4), and discuss their project ideas with their faculty before finalising their research areas. The project is done using Open-source software(s), which are easily available with applications ranging from development to research-based projects or mix of both. This helps students in understanding the working of project development in companies and also broadens the spectrum for team work and procedural implementation of projects in hand to be delivered to clients as per the requirements.

Evaluation Criteria

Components	**Maximum Marks**
Fortnightly Assessment 1,2&3	30
Viva Voce at the end of semester	30
End of semester Report & Presentation	25
Attendance	15
Total	**100**

Detailed Syllabus
Lecture-wise Breakup

Course Code	18M12CS115	**Semester (Even)**	**Semester II Session** 2020 -2021 **Month from Jan to June, 2021**
Course Name	Internet of Things		
Credits	**3**	**Contact Hours**	**3 Lectures**

Faculty (Names)	**Coordinator(s)**	Dr. Chetna Dabas
	Teacher(s) (Alphabetically)	1. Dr. Chetna Dabas 2. Dr K. Rajalakshmi

COURSE OUTCOMES		**COGNITIVE LEVELS**
C151.1	Identification of purpose, requirements and description of various components and specifications of IoT devices, applications and protocols.	Understand (level 2)
C151.2	Develop the Process Model, Domain Model, Information Model and Service Model specifications using IoT communication protocols.	Apply (level 3)
C151.3	Analyze the characteristics and functioning of various IoT specific communication protocols used in different layers of IoT devices.	Analyze (level 4)
C151.4	Evaluate various IoT protocols and components for building IoT applications for real world problems and sustainable solutions.	Evaluate (level 5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction to Internet of Things	Introduction to Internet of Things, Layers in IoT, IoT Communication Protocols at different layers, Design steps for IoT, IoT Enabling Technologies, IoT Levels.	5(CO1)
2.	IoT platforms design methodology	IoT Design methodology, Purpose and requirement specifications, Process, Domain, Information Model specifications, Service specifications and application development.	5(CO2)
3.	IEEE 802.15.4	The Physical Layer, MAC Layer, MAC Layer Frame Format and their uses.	3(CO3)
4.	ZigBee	ZigBee Architecture, Association, ZigBee Network Layer, APS Layer, ZDO, Security, ZCL etc.	3(CO3)
5.	Internet Connecting Principles	Introduction to Arduino and Raspberry Pi, Connectivity with other components, internet connectivity, IP addressing in IoT, Media Access Control, and Application Layer Protocols: MQTT, CoAP, XMPP.	7(CO3)
6.	Design Principles for Web Connectivity	Web Communication Protocols for Connected Devices, Message communication Protocols, Web connectivity : SOAP, REST, HTTP RESTFUL, Web Sockets	4(CO3)
7.	Data Acquiring ,	Data Acquiring and Storage, Organizing the data,	4(CO3)

	Organizing, Processing and Analytics	Transactions, Business Processes, Integration and Enterprises Systems, Analytics, Knowledge Acquiring, Managing and Storing process	
8.	Data Collection, Storage and Computing using Cloud Computing	Cloud computing paradigms for Data Collection, Storage and Computing, Cloud Service Models, IoT Cloud-based Services.	6(CO3)
9.	IoT Applications for Sustainable developments.	Energy Savings in IoT, Green IoT Applications developments for sustainability.	3(CO4)
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignments, Presentations of assigned topics)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Internet of Things: A Hands-On Approach, Arshadeep Bagha and Vijay Madisetti.
2	The Internet of Things: Key Applications and Protocols, Oliver Hersent, David Boswarthick, Omar Elloumi, Wiley.
3.	Internet of Things: Architecture and Design Principles, Raj Kamal, McGrawHill
4.	6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
5.	Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications, Daniel Minoli John Wiley & Sons

Detailed Syllabus

Subject Code	19M12CS211	**Semester Even**	**Semester II sem Session EVEN 2021 Month from Jan to June**
Subject Name	Nature Inspired Computation and Applications		
Credits	**3**	**Contact Hours**	**3**

Faculty (Names)	**Coordinator(s)**	Dr. Anuja Arora
	Teacher(s) (Alphabetically)	Dr. Anuja Arora

SNO	Description	Cognitive Level (Bloom Taxonomy)
CS151.1	Identify the need of computational complexity, evolutionary, and approximate algorithms.	Apply Level (Level 3)
CS151.2	Understand nature inspired algorithms, its strength, weakness, and suitability	Understand Level (Level 2)
CS151.3	Make use of nature-inspired algorithms to design, learn and optimize problem	Apply Level (Level 3)
CS151.4	Evaluate performance of Nature inspired algorithm in context of problem solving in optimized manner	Evaluate Level (Level 5)
CS151.5	Create a real environment effective artificial system with the use of properties exhibited from nature.	Create Level (Level 6)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Nature Inspired Computation Fundamental	Computational Complexity, NP-Hardness, Reductions, Approximation Algorithms vs. Heuristics, Newton Raphson Method, Characteristics of Natural Systems/Algorithms	3
2.	Empirical and Evolutionary Algorithms	Empirical Algorithms, Empirical hardness. Evolutionary Algorithms, optimization Fitness landscape Analysis, EA Theory	4
3	Evolutionary Algorithms	Genetic Algorithm, GA Encoding Techniques, Selection techniques, Variation(Crossover and Mutation) Techniques, Genetic Programming Differential Evolution Algorithm, sample problems, DE-Crossover and Mutation techniques	8
4	Swarm Intelligence	Particle Swarm Optimization Binary PSO	17

	Algorithm	Ant Colony Optimization Artificial Bee Colony Algorithm, Cuckoo Search Firefly Algorithm BAT Algorithm	
5	Miscellaneous Optimization Algorithm	Gravitational Search Algorithm Teaching Learning Based Optimization Nondominated sorting genetic algorithm II (NSGA-II) Artificial Immune System Self-organizing Maps	8
11	NIC in Real Context	Constraint Handling, Parallelization and vectorization of Fitness Function. Case Studies: World Wide Web, Social Network, Modeling, Image Processing, Earthquake, routing & scheduling	2
		Total number of Lectures	**42**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25
	Attendance = 10 Class Test/Quiz = 10 Mini-Project = 5
Total	100

Project Based Learning: Students will form a group of 2-3 students. To design a problem statement, students read 4-5 research papers in which nature inspired computational algorithms have been used to handle real scenario problems. Theme and topic of project is chosen based on read research papers. Understanding usage of appropriate optimization technique, then implementation of the selected optimization algorithm and evaluating its effectiveness based on performance measure help students to know the concept of applying the optimization techniques in real life case scenario.

Text Books Books	
1.	Evolutionary Optimization Algorithms, D. Simon (2013), Wiley.
2.	Yang, X. S. (Ed.). (2017). Nature-inspired algorithms and applied optimization (Vol. 744). Springer.

Reference Books	
1.	Eberhart, Russell C., and Yuhui Shi. Computational intelligence: concepts to implementations. Elsevier, 2011
2.	Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies, D.Floreano and C. Mattiussi (2008), MIT Press.
3.	Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications, L. N. de Castro (2006), CRC Press.

4.	Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
5.	Marco Dorrigo, Thomas Stutzle," Ant Colony Optimization", PHI,2005
6.	Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
7.	Coello, C. C., Dhaenens, C., & Jourdan, L. (Eds.). (2009). Advances in multi-objective nature inspired computing (Vol. 272). Springer.