Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
(Applicable from academic year 2019-20)

Curriculum Structure							
Semester-I							
Sl. No.	**Category**	**Course Code**	**Course Name**	**Total Number of contact hours**			**Credits**
				L	**T**	**P**	
Theory							
1	Program Core I	PGCS-101	Mathematical foundations of Computer Science	3	0	0	3
2	Program Core II	PGCS-102	Advanced Data Structures	3	0	0	3
3	Program Elective-I	PGCS-103	Program Elective-I	3	0	0	3
4	Program Elective-II	PGCS-104	Program Elective-II	3	0	0	3
5		PGCS-105	Research Methodology and IPR	2	0	0	2
6	Audit Course 1		Audit Course 1	2	0	0	0
	Total Theory			**16**	**0**	**0**	**14**
Practical							
7	Laboratory I	PGCS-191	Advanced Data Structures	0	0	2	2
8	Laboratory II	PGCS-192	Laboratory II [from Elective – I]	0	0	2	2
	Total Practical			**0**	**0**	**4**	**4**
	Total of Semester-I			**16**	**0**	**4**	**18**
Semester-II							
Theory							
1	Program Core III	PGCS-201	Advances in Algorithms	3	0	0	3
2	Program Core IV	PGCS-202	Soft Computing	3	0	0	3
3	Program Elective-III	PGCS-203	Program Elective-III	3	0	0	3
4	Program	PGCS-	Program Elective-IV	3	0	0	3

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	Elective-IV	204					
5	Audit Course 2		Audit Course 2	2	0	0	0
	Total Theory			**14**	**0**		**12**
Practical							
6	Laboratory III	PGCS-292	Laboratory III (Advances in Algorithm)	0	0	2	2
7	Laboratory IV	PGCS-293	Laboratory IV (from Elective-III)	0	0	2	2
	Total Practical			**0**	**0**	**4**	**4**
Sessional							
8	Mini Project	PGCS-294	Mini Project with Seminar	0	0	3	2
	Total Sessional			0	0	3	2
	Total of Semester-II			**12**	**0**	**7**	**18**
Semester-III							
Theory*							
1	Program Elective-V	PGCS-301	Program Elective-V	3	0	0	3
2	Open Elective	PGCS-302	Open Elective	3	0	0	3
	Total Theory			**6**	**0**	**0**	**6**
Sessional							
3	Major Project	PGCS-391	Dissertation –I	0	0	20	10
				0	0	20	10
	Total of Semester-III						**16**
Semester-IV							
Sessional							
1	Major Project	PGCS-491	Dissertation -II	0	0	32	16
			Total of Semester-IV				**16**
Total Credits for the programme							**68**

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List of Electives

- **Program Elective – I(PGCS-103)**
  - A. Machine Learning
  - B. Operating System Design
  - C. Object Oriented Design

- **Program Elective – II (PGCS-104)**
  - A. Advance Wireless and Mobile Networks
  - B. Embedded System
  - C. Quantum Computing
  - D. Pattern Recognition

- **Program Elective – III**
  - A. Advances in DBMS
  - B. Artificial Intelligence
  - C. Object Oriented Software Engineering
  - D. Secure Software Design and Enterprise Computing
  - E. Computer vision

- **Program Elective – IV**
  - A. Human Computer Interaction
  - B. Theory of Computation
  - C. Cloud Computing
  - D. Network Security
  - E. VLSI Design

- **Program Elective - V**
  - A. Natural Language Processing
  - B. Bioinformatics
  - C. IOT and Its Security
  - D. Digital Forensics
  - E. Advances in Compiler Construction

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❖ **Open Elective**

A. Business Analytics
B. Operations Research
C. Cost Management of Engineering Projects
D. Industrial Safety
E. Composite Materials
F. Waste to Wealth
G. Industry Overview (Enterprise & Solution Architecture)

Audit course 1 & 2

A. English for Research Paper Writing
B. Pedagogy Studies
C. Constitution of India
D. Disaster Management
E. Value Education
F. Stress Management by Yoga
G. Personality Development through Life Enlightenment Skills.
H. Sanskrit for Technical Knowledge

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Course Code	**PGCS101**
Course Name	**Mathematical Foundation of Computer Science**
Credits	**3**
Pre-Requisites	**Discrete Mathematics**

COURSE OBJECTIVES

Total Number of Lectures: 36

• To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
• To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
• To study various sampling and classification problems.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit1 Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Marko chains	**6**
Unit 2 Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood	**6**
Unit 3 Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of over-fitting model assessment.	**6**

Unit 4 Graph Theory: Isomorphism, Planar graphs, graph colouring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems	**6**
Unit 5 Computer science and engineering applications. Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.	**6**
Unit 6 Recent Trends in various distribution functions in mathematical field of computer science for varying fields like bioinformatics, soft computing, and computer vision.	**6**

COURSE OUTCOMES

After completion of course, students would be able to:

1.	To understand the basic notions of discrete and continuous probability.
2.	To understand the methods of statistical inference, and the role that sampling distributions play in those methods.
3.	To be able to perform correct and meaningful statistical analyses of simple to moderate complexity.

References:

1. John Vince, Foundation Mathematics for Computer Science, Springer.
2. K. Trivedi. Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.
3. M. Mitzenmacher and E. Upfal. Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
4. Alan Tucker, Applied Combinatorics, Wiley.

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Course Code	**PGCS102**
Course Name	**Advanced Data Structure**
Credits	**3**
Pre-Requisites	**Under graduate level Data structure knowledge**

COURSE OBJECTIVES Total Number of Lectures: 36

● The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
● Students should be able to understand the necessary mathematical abstraction to solve problems.
● To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
● Student should be able to come up with analysis of efficiency and proofs of correctness.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	**6**
Unit 2 Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists	**6**
Unit 3 Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees	**6**
Unit 4 Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries,	**6**

Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	
Unit 5 Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quad-trees, k-D Trees.	**6**
Unit 6 Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem	**6**

COURSE OUTCOMES

After completion of course, students would be able to:

1.	Understand the implementation of symbol table using hashing techniques.
2.	Develop and analyse algorithms for red-black trees, B-trees and Splay trees.
3.	Develop algorithms for text processing applications.
4.	Identify suitable data structures and develop algorithms for computational geometry problems.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

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Course Code	PGCS103A
Course Name	Machine learning
Credits	3
Pre-Requisites	Basic Mathematics, Algorithms

Total Lecture: 36 L

COURSE OBJECTIVE	
1	To explore supervised and unsupervised learning paradigms of machine learning.
2	To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances
3	To explore Deep learning technique and various feature extraction strategies

LECTURE WITH BREAKUP	**HOURS**
Unit1: ● Basic concepts of learning, Hypothesis Space, Basic statistics: Probability, Bayes Theorem, Naïve Bayes, Bayesian network ● Regression Analysis: Correlation, Bivariate and Multivariate regression, Types of regression – Linear, Logistic, Non-linear or Polynomial	**6**
Unit2: ● Supervised, Unsupervised, Semi-supervised learning, Instance-based learning, k-Nearest Neighbourhood, Ensemble methods – Bagging, Boosting and Stacking ● Support Vector Machine: Working principle, Linear Discriminant Analysis (LDA), Non-linearity and kernel methods	6
Unit 3: ● Decision Trees: Introduction and building, Algorithms used – ID3, Information Gain, Gini Index, Chi-square, Reduction in variance, Overfitting and Under fitting, L1 and L2 regularisation, Random Forest ● Dimensionality reduction: Principle Component Analysis (PCA), Independent Component Analysis (ICA), Singular Valued Decomposition (SVD)	**6**
Unit 4: ● Artificial Neural Network: Biological Neuron, MP Neuron, HEVNet, Perceptron, Multilayer Perceptron, Gradient descent, Back-propagation algorithm ● Convolution Neural Network(CNN), Recurrent Neural Network(RNN), Long Short Term Memory Network(LSTM)	**6**

Unit 5: ● Clustering techniques: k-means, Mean-Shift Clustering, Density-Based Spatial Clustering of Applications with Noise (DBSCAN), Hierarchical clustering ● Reinforcement Learning: The Learning Task, Q Learning, Algorithm, Non-deterministic Rewards and Actions	**6**
Unit 6: ● Advanced topics: Modelling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning, Inference in Graphical Models ● Evaluating Machine Learning algorithms and Model Selection and real-life applications	**6**

COURSE OUTCOMES:

After completion of course, students would be able to:

1.	Extract features that can be used for a particular machine learning approach in various real life applications.
2.	To mathematically analyse various machine learning approaches and paradigms.
3.	To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. Tom M. Mitchell, Machine Learning, McGraw-Hill,1997(freely available online)

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Course Code	**PGCS-103–B**
Course Name	**Operating System Design**
Credits	**3**
Pre-Requisites	**Data Structure, Algorithms, Computer Architecture and Organization**

COURSE OBJECTIVE

Total Number of Lectures: 36

- The objective of the course is to provide introduction to operating system design and concept of process, process lifecycle and scheduling approaches

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Computer system and operating system overview, Operating system functions and design issues, Design approaches, Types of advanced operating systems.	**6**
Unit 2: Process abstraction, Process management, system calls, Threads, symmetric multiprocessing and micro-kernels.	**6**
Unit 3: Scheduling: Uni-processor, Multiprocessor and Real time systems, concurrency, classical problems, mechanisms for synchronization: semaphores, monitors, Process deadlock and deadlock handling strategies.	**6**
Unit 4: Memory management, Virtual memory concept, Virtual machines, I/O management, File and disk management, Operating system security.	**6**
Unit 5: Distributed Operating system: Architecture, Design issues, distributed mutual exclusion, distributed deadlock detection, shared memory, Distributed scheduling.	**6**
Unit 6: Recent trends in Operating system design and their applicability to HPC.	**6**

COURSE OUTCOMES

After completion of course, students would be able to:

1. Understanding advanced concepts in operating systems.
2. Learning principles of Distributed and multiprocessor operating systems

References:

1. Advanced concept in operating system: M. Singhal, N.G. Shivratri
2. Operating system internal and design principles: William Stallings
3. Distributed Operating systems by Andrew S. Tanenbam

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Course Code	**PGCS103C/PGSE103C**
Course Name	**Object Oriented Design**
Credits	**3**
Pre-Requisites	**Data Structure, Algorithms, Computer Architecture and Organization**

Prerequisites of Object Oriented Programming:	The fundamental point in learning programming is to develop the critical skills of formulating programmatic solutions for real problems. It will be based on basic knowledge of algorithms and object oriented programming language. Once the basic skill of writing programs using loop, methods and arrays will be clear then the student can develop object oriented software using class encapsulation and inheritance.
Course Objectives:	**1.** To develop conceptual understanding of Object Oriented System. **2.** To understand how a real world problem can be mapped to object oriented problem domain. **3.** To solve different industry level problems & to learn its applications.
Course Outcome:	Upon successful completion of the course students should be able to: **CO1:** Visualize a given problem scenario in terms of classes and objects. **CO2:** Acquire the knowledge about different types of inheritance & polymorphism, interface, package, vector and wrapper class. **CO3:** Apply object oriented programming concepts through Java for problem solving. **CO4:** Acquire knowledge about threads, thread synchronization and applets and their life cycle.

Total Number of Lectures:	**36**

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Syllabus:

MODULE 1:

Object oriented concepts

Difference between OOP and other conventional programming approaches– advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism, dynamic binding

MODULE 2:

Basic concepts of object oriented programming using Java

Implementation of Object oriented concepts using Java. Basic concepts of java programming – advantages of java, byte-code & JVM, data types, operators, control statements & loops. How to create objects and classes. Memory management involved with object and class creation, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, command line arguments, basics of I/O operations – keyboard input using Buffered Reader & Scanner classes.

MODULE 3:

Reusability properties

Super class & subclasses including multilevel hierarchy, process of constructor chaining, dynamic method dispatch, use of abstract classes & methods, abstract class and abstract class hierarchy, Compile time polymorphism and runtime polymorphism

MODULE 4:

Array, String, Vector and Wrapper classes

Creation of multi-dimensional arrays, Creation of vectors, Differences between arrays and vectors, methods of the Vector class, String and String Buffer class, methods associated with the String and String Buffer class, Utility of the wrapper classes, different types of wrapper classes

MODULE 5:

Interface and Package

How to create interfaces, what is an interface, differences between class and interface, Multiple inheritance using interface, using existing packages, Advantages of packages, Creation of user defined packages, importing packages, member access for packages, Different access specifiers.

MODULE 6:

Exception handling

Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes.

MODULE 7:

Multithreading

Difference between process and threads, Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter- thread communication, deadlocks for threads, suspending & resuming threads.

MODULE 8:

Applet Programming

Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applets, concept of delegation event model and listener, I/O in applets.

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LECTURE WITH BREAKUP	NO. OF LECTURES
MODULE 1: **Object oriented concepts** Difference between OOP and other conventional programming approaches– advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism, dynamic binding	**[3]**
MODULE 2: **Basic concepts of object oriented programming using Java** Implementation of Object oriented concepts using Java. Basic concepts of java programming – advantages of java, byte-code & JVM, data types, operators, control statements & loops. How to create objects and classes. Memory management involved with object and class creation, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value and call by reference, static variables & methods, command line arguments, basics of I/O operations – keyboard input using Buffered Reader & Scanner classes.	**[5]**
MODULE 3: **Reusability properties** Super class & subclasses including multilevel hierarchy, process of constructor chaining, dynamic method dispatch, use of abstract classes & methods, abstract class and abstract class hierarchy, Compile time polymorphism and runtime polymorphism	**[5]**
MODULE 4: **Array, String, Vector and Wrapper classes**	**[4]**

Creation of multi-dimensional arrays, Creation of vectors, Differences between arrays and vectors, methods of the Vector class, String and String Buffer class, methods associated with the String and String Buffer class, Utility of the wrapper classes, different types of wrapper classes	
MODULE 5: **Interface and Package** How to create interfaces, what is an interface, differences between class and interface, Multiple inheritance using interface, using existing packages, Advantages of packages, Creation of user defined packages, importing packages, member access for packages, Different access specifiers.	**[4]**
MODULE 6: **Exception handling** Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes.	**[4]**
MODULE 7: **Multithreading** Difference between process and threads, Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter- thread communication, deadlocks for threads, suspending & resuming threads.	**[5]**
MODULE 8: **Applet Programming** Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applets, concept of delegation event model and listener, I/O in applets.	**[6]**

Textbooks/References:

1. Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
2. Ali Bahrami – "Object Oriented System Development" – Mc Graw Hill
3. Patrick Naughton, Herbert Schildt – "The complete reference-Java2" – TMH
4. R.K Das – "Core Java For Beginners" – VIKAS PUBLISHING
5. Deitel and Deitel – "Java How to Program" – 6th Ed. – Pearson
6. Ivor Horton's Beginning Java 2 SDK – Wrox
7. E. Balagurusamy – " Programming With Java: A Primer" – 3rd Ed. – TMH

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Course Code	**PGCS-104-A**
Course Name	**Advance Wireless and Mobile Networks**
Credits	**3**
Pre-Requisites	**Computer Networks**

COURSE OBJECTIVES Total Number of Lectures: 36

● The students should get familiar with the wireless/mobile market and the future needs and challenges.
● To get familiar with key concepts of wireless networks, standards, technologies and their basic operations.
● To learn how to design and analyse various medium access.
● To learn how to evaluate MAC and network protocols using network simulation software tools.
● The students should get familiar with the wireless/mobile market and the future needs and challenges.

LECTUREWITHBREAKUP	**NO. OF LECTURES**
Unit1: **INTRODUCTION:** Wireless Networking Trends, Key Wireless Physical Layer Concepts, Multiple Access Technologies-CDMA, FDMA, TDMA, Spread Spectrum technologies, Frequency reuse, Radio Propagation and Modelling, Challenges in Mobile Computing: Resource poorness, Bandwidth, energy etc. **WIRELESSLOCALAREANETWORKS:** IEEE 802.11WirelessLANsPhysical&MAClayer, 802.11 MAC Modes (DCF &PCF) IEEE802.11standards, Architecture &protocols, Infrastructures. Adhoc	**6**

Modes, Hidden Node & Exposed Terminal Problem, Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues	
Unit 2: **WIRELESS CELLULAR NETWORKS:** 1G, 2G,2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks, Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, improving coverage and capacity in cellular systems, Spread spectrum Technologies.	**6**
Unit 3: WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE 802.22 Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover Overview **WIRELESS SENSOR NETWORKS:** Introduction, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS Overview.	**6**
Unit 4: **WIRELESS PANs:** Bluetooth and Zigbee, Introduction to Wireless Sensors,	**6**
Unit 5: **SECURITY:** Security in wireless Networks Vulnerabilities, Security techniques, Wi-Fi Security, DoS in wireless communication.	**6**
Unit 6: **ADVANCED TOPICS:** IEEE 802.11x and IEEE 802.11i standards, Introduction to Vehicular Adhoc Networks	**6**

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COURSE OUTCOMES

After completion of course, students would be able to:

1.	Demonstrate advanced knowledge of networking and wireless networking and understand various types of wireless networks, standards, operations and use cases.
2.	Be able to design WLAN, WPAN, WWAN, Cellular based upon underlying propagation and performance analysis.
3.	Demonstrate knowledge of protocols used in wireless networks and learn simulating wireless networks.
4.	Design wireless networks exploring trade-offs between wire line and wireless links.
5.	Develop mobile applications to solve some of the real world problems.

References

1. Schiller J., Mobile Communications, Addison Wesley 2000
2. Stallings W., Wireless Communications and Networks, Pearson Education 2005
3. Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc 2002
4. Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc 2000
5. Pandya Raj, Mobile and Personal Communications Systems and Services, PHI 200

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Course Code	**PGCS-104-B**
Course Name	**Embedded System**
Credits	**3**
Pre-Requisites	**UG level course in microprocessor & microcontroller**

COURSE OBJECTIVES Total Number of Lectures: 36

● Student should learn microcontroller and Embedded Systems
● Student should learn Embedded System Design issues
● Student should learn Testing of an Embedded System
● Student should learn Real Time Operating System for Embedded systems

LECTUREWITHBREAKUP	NO. OF LECTURES
Unit 1: **Concept of Embedded system:** Basic of Embedded Systems, List of various applications, Difference between embedded system and general purpose computer systems, Classification of embedded systems. **Market trend Basics of Hardware Software Co-Design:** Co-Design Types: Microprocessors/ Microcontrollers/DSP based Design, FPGA/ASIC based Design, & Hybrid Design. **Methodology:** System specifications, co-specifications of hardware and software, System Design Languages, System modelling/ simulation, Partitioning, Co-verification, Co-implementation. **Embedded System Development Cycle and Y-chart:** Data-flow in Embedded systems: Sensors and Transducers, ADC/DAC, Interfacing of ADC/DAC with Processors	**9**
Unit 2	**9**

Embedded System Design: Design Challenges of Embedded System: Design goal, key design challenges, performance, size, power, unit cost and NRE cost etc. and Time to market. **Interfacing of peripherals with Microprocessors Embedded System Design Issues:** Hardware issues: i) Processor, ii) Memory, iii) Peripherals, Software issues: i) Programming Languages, ii) Time Criticality, iii) RTOS. **Testing and Debugging issues:** Concept of Microcontroller and FPGA based Embedded System design, & Discussion of embedded system related projects.	
Unit 3 **Testing & Debugging of Embedded System:** Testing Phase, Testing Tools, Software Testing Techniques (White Box, Black Box, Alpha, Beta, Regression Testing etc.), Load and Stress Testing, Differences between Simulator and Emulator, Hardware Testing by CRO, DSO, Logic analyser etc. **Embedded System Testing by ICE(In-Circuit-Emulator):** What is ICE, Operation principle of ICE, Important Features of ICE. Embedded System Testing by JTAG Technology: What is JTAG, Iportance of JTAG Technology, Features of Boundary Scan, Principle of Boundary Scan, Operation of Basic Boundary Scan Cell (BSC), Test process of Boundary Scan, Advantages of Boundary Scan B Features of Boundary Scan.	**8**
Unit 4: **Real Time Operating Systems (RTOS) for Embedded System:** **Real Time Operating System:** What is RTOS and why used in Embedded system, Hard, Soft and Firm Real time system, Selection of RTOS, Difference between RTOS and conventional operating system, Example of RTOS, Basic structure of RTOS. **Some definitions:** Jobs, Task, Processors, resources, Release time of a job, Dead line of a job, Response time, Relative and absolute deadline, Execution time, Tardiness of job, Precedence constrains and data dependency, pre-emptive job, Context switch time, Criticality of job etc., Model for Real Time System, Classification of Real time applications for Embedded system, Periodic Task Model (Period, Phase Hyper period), Aperiodic and Sporadic Task **Real Time Scheduling for Embedded System:** Why Real Time Scheduling, Scheduling, Scheduler, Schedule, Valid Schedule,	**10**

Feasible Schedule, Optimal Schedule, Static Scheduling, Dynamic Scheduling, Types of Scheduler (Clock or time Driven, Priority driven, and Weighted round Robin), Details of Weighted Round Robin, Clock or Time Driven Scheduling with suitable Example. **Priority Driven Scheduling:** Characteristics and Assumption Fixed Priority and Dynamic Priority: RMS and EDF algorithm with Examples.	

COURSE OUTCOMES

After completion of course, students would be able to:

1.	Understand the basic concept of embedded system and it classifications and applications.
2.	Design embedded system by combining of hardware & software.
3.	Test an embedded system.
4.	Design algorithm for real time processing for embedded system

References

1. Raj Kamal, Embedded System Architecture, Programming and Design, TMH, 2008.
2. R. Gupta, Co-synthesis of Hardware and Software for Embedded System (Kluwer 1995)
3. Jane W. S. Liu, Real-Time Systems, Pearson, 2000.
4. Tammy Noergaard, Embedded Systems Architecture – a comprehensive guide for engineers and programmers, Elsevier, 2006.
5. Lyla B. Das, Embedded Systems- an integrated approach, 2013.
6. A.K Ganguly, Embedded Systems – design, programming and applications, Narosa Publishing House Pvt. Ltd., 2014.

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Course Code	**PGCS-104C**
Course Name	**Quantum Computing**
Credits	**3**
Pre-Requisites	**Familiarity with basics of quantum mechanics and computer science, Discrete Structures**

COURSE OBJECTIVES Total Number of Lectures: 36

• To understand the quantum information theory, quantum circuits and reversible circuits with its application to quantum computation and quantum cryptography.
• To develop the understanding of current Quantum Computer physical implementations and Quantum machine learning
• To implement basic quantum algorithms.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit1 Introduction to Quantum Computation: Quantum bits, Bloch sphere representation of a qubit, multiple qubits.	**4**
Unit 2 Background Mathematics and Physics: Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.	**6**
Unit 3 Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits, Reversible gate and Circuits, Representation of Reversible Gate and Circuits, Fault Models in Reversible Circuits.	**6**
Unit 4 Quantum Information and Cryptography: Comparison between classical and	**7**

quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem.	
Unit 5 Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.	**7**
Unit 6 Noise and error correction: Graph states and codes, Quantum error correction, fault-tolerant computation. Various current Quantum Computer physical implementations, Quantum machine learning	**6**

COURSE OUTCOMES

After completion of course, students would be able to:

● Learn the framework of quantum computation, and how that may be useful for future quantum technologies
● Understand the quantum information theory, Quantum gates and Reversible gates, quantum computation, quantum cryptography and related topics. Understand quantum algorithms
● Aware of some state-of-the-art physical implementations
● Understand developing concepts wrt quantum machine learning

References:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press,2002.
2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific,2004.
3. Pittenger A. O., An Introduction to Quantum Computing Algorithms,2000. Mikio Nakahara and Tetsuo Ohmi,"Quantum Computing", CRC Press (2008).

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
(Applicable from academic year 2019-20)

Course Code	**PGCS-104D**
Course Name	**Pattern Recognition**
Credits	**3**
Pre-Requisites	**Basic Mathematics**

COURSE OBJECTIVES Total Number of Lectures: 36

● To understand the concept of a pattern and the basic approach to the development of pattern recognition algorithms.
● To understand the concepts of data processing with the help of feature extraction, feature evaluation, and data mining.
● To apply both classification and clustering methods to recognize patterns in real-world problems.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **Introduction to Pattern Recognition**: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis	**6**
Unit 2: **Linear models**: Linear Models for Regression, linear regression, logistic regression Linear Models for Classification	**8**
Unit 3: **Neural Network**: Perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods, Adaboost, Deep Learning	**8**

Unit 4: **Linear discriminant functions**: Decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine	**6**
Unit 5: **Algorithm independent machine learning** – Lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers	**4**
Unit 6: **Unsupervised learning and clustering** – k-means clustering, fuzzy k-means clustering, hierarchical clustering	**4**

COURSE OUTCOMES

After completion of course, students would be able to:

1.	Study the parametric and linear models for classification.
2.	Design neural network and SVM for classification.
3.	Develop machine independent and unsupervised learning techniques.

References:

1. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition John Wiley & Sons, 2001.
2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.
3. C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
4. Konstantinos Koutroumbas, Sergios Theodoridis, "Pattern Recognition", Academic Press; 4 edition (November 3, 2008).

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
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Course Code	**PGCS105**
Course Name	**Research Methodology and IPR**
Credits	**2**
Pre-Requisites	

COURSE OBJECTIVES: Total Number of Lectures:24

1.	Understand research problem formulation.
2.	Analyse research related information
3.	Follow research ethics
4.	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5.	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6.	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

COURSE OUTCOMES

After completion of course, students would be able to:

LECTURE WITH BREAKUP	**NO. OF LECTURES (1Hr/Wk)**
Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	**4**

Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics.	**4**
Unit 3: Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	**4**
Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**4**
Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	**4**
Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	**4**

References

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 nd Edition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Maulana Abul Kalam Azad University of Technology, West Bengal
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(Applicable from academic year 2019-20)

Course Code	**PGCS 191**
Course Name	**Advanced Data Structures**
Credits	**2**
Pre-Requisites	**Basic knowledge of C programming, Data structure and Unix Shell Commands,**

Total Number of Lectures: 36

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 Implementation of Stack and Queue.	**3**
Unit 2 Implementation of different hashing techniques and Skip Lists	**6**
Unit 3 Implementation of Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees	**9**
Unit 4 Implementation of different Text Processing algorithms: Basic String Operations (concatenation of two string, pattern search) Implementation of Boyer- Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries for Pattern Matching, The Huffman Coding Algorithm, Implementation of Longest Common Subsequence Problem (LCS).	**9**
Unit 5 Implementation of One Dimensional & Two Dimensional Range Search algorithm, Implementation of Priority Search Tree & searching on it, Quad trees, k-D Trees	**9**

References

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.

2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	**PGCS-192-A**
Course Name	**Machine Learning**
Credits	**2 (36) P**
Pre-Requisites	**Python Programming and Basic Statistics**

Total Number of Lectures: 36P

Sl. No.	Assignments
1	Write a program to demonstrate the working of decision trees algorithm. Use an appropriate dataset for building the decision tree and apply this knowledge to classify a new sample.
2	Write a program to demonstrate the working of support vector machine algorithm. Use an appropriate dataset and apply this knowledge to classify a new sample.
3	Write a program to implement k-Nearest Neighbour algorithm to classify a real life dataset. Print both correct and wrong predictions. Python ML library classes may be used for this problem.
4	Write a python program to implement random forest algorithm to classify real life dataset.
5	Write a python program to implement Naïve Bayes algorithm in real life dataset classification.
6	Write a python program to implement K-means algorithm on real life dataset.
7	Write a python program to implement linear and logistic regression in real life dataset.
8	Write a python program to implement deep learning in real life dataset.
9	Write a python program to implement PCA in real life dataset.
10	Project: Implement ML Techniques to solve problems in Bio-informatics

References

1. Machine Learning in Action - Peter Harrington
2. Programming Collective Intelligence: Building Smart Web 2.0 Applications - Toby Segaran
3. Machine Learning: An Algorithmic Perspective - Stephen Marsland

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	**PGCS-192-B**
Course Name	**Operating Systems Design**
Credits	**2**
Pre-Requisites	**UG level Operating Systems**

Total Number of Lectures: 36P

LECTURE WITH BREAKUP	**NO. OF LECTURES**
1. Fundamentals of Operating System	**6**
2. Shell scripting	**9**
3.Familiarization with UNIX system calls for process management and inter-process communication	**9**
4. Experiments on process scheduling and other operating system tasks through simulation/implementation under a simulated environment	**12**

Text Books:

1. Avi Silberschatz, Peter Galvin, Greg Gagne, Operating System Concepts, Wiley Asia Student Edition.
2. William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall of India.

Reference Books:

1. Gary J. Nutt, Operating Systems: A Modern Perspective, Addison-Wesley.
2. Maurice Bach, Design of the Unix Operating Systems, Prentice-Hall of India.
3. Daniel P. Bovet, Marco Cesati, Understanding the Linux Kernel, O'Reilly and Associates.

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	**PGCS-192C/PGSE-192C**
Course Name	**Object Oriented Design Practical**
Credits	**2**
Pre-Requisites	**Basic knowledge of programming concept, Data Structure and Algorithm**

Course Objectives:	**1.** To develop conceptual understanding of Object Oriented System. **2.** To understand how a real world problem can be mapped to object oriented problem domain. **3.** To solve different industry level problems & to learn its applications.
Course Outcome:	Upon successful completion of the course students should be able to: **CO1:** Understand the object oriented approach of software development. **CO2:** Learn about proper object oriented design principles while focussing on the reusability concept. **CO3:** Implement a given design using Java

Syllabus:

Total Number of Lectures: 36P

1. Assignments on class, constructor, function overloading, constructor overloading
2. Assignments on inheritance, constructor chaining, run-time polymorphism
3. Assignments on arrays, Strings
4. Assignments on wrapper class, Vector
5. Assignments on developing interfaces- multiple inheritance, extending interfaces
6. Assignments on wrapper handling exceptions, creations of user defined exceptions

7. Assignments on creating and accessing packages
8. Assignments on multithreaded programming, inter-thread communication, thread synchronization, deadlock
9. Assignments on applet programming

Textbooks/References:

1. Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
2. Ali Bahrami – "Object Oriented System Development" – Mc Graw Hill
3. Patrick Naughton, Herbert Schildt – "The complete reference-Java2" – TMH
4. R.K Das – "Core Java For Beginners" – VIKAS PUBLISHING
5. Deitel and Deitel – "Java How to Program" – 6th Ed. – Pearson
6. Ivor Horton's Beginning Java 2 SDK – Wrox
7. E. Balagurusamy – " Programming With Java: A Primer" – 3rd Ed. – TMH

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	**PGCS-201**
Course Name	**Advances in Algorithms**
Credits	**3**
Pre-Requisites	**UG level course in Algorithm Design and Analysis**

Total Number of Lectures:36

COURSE OBJECTIVE
• To equip students with different design paradigms and data structures to solve advanced algorithmic problems.
• Students should be able to understand different classes of problems concerning their computational hardness.
• The students should be able to choose or design an efficient approximation algorithm to solve a computationally hard problem.

Lecture distribution	**No of Lectures**
Unit 1 Sorting: Review of various sorting algorithms, topological sorting Graph: Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.	**6**
Unit 2 Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. Graph Matching: Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.	**5**
Unit 3 Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm. Matrix Computations: Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.	**6**
Unit 4 Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming. Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to	**9**

polynomials. Application: Interpolation problem. Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm	
Unit 5 Linear Programming: Geometry of the feasibility region and Simplex algorithm NP-completeness: Examples, proof of NP-hardness and NP-completeness. One or more of the following topics based on time and interest: Approximation algorithms, Randomized Algorithms, Interior Point Method, Advanced Number Theoretic Algorithm	**6**
Unit 6 Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.	**4**

COURSE OUTCOMES
After completion of course, students would be able to:
● Analyse the complexity/performance of different algorithms.
● Determine the appropriate data structure for solving a particular set of problems.
● Categorize different problems in various classes according to their complexity and know how to approach towards computationally hard problems

References:

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3. "Algorithm Design" by Kleinberg and Tardos.
4. “Combinatorial Optimization: Algorithms and Complexity” by C.H. Papadimitriou, K. Steiglitz,

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Course Code	**PGCS202**
Course Name	**Soft Computing**
Credits	**3**
Pre-Requisites	**Basic knowledge of mathematics**

Total Number of Lectures:36

COURSE OBJECTIVE
• To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
• To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
• To provide students an hand-on experience on MATLAB/Python to implement various strategies.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 **INTRODUCTION TO SOFT COMPUTING:** Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence:	**3**
Unit 2 **FUZZY LOGIC:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.	**9**
Unit 3 **NEURAL NETWORKS:** Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks	**9**
Unit 4 **Meta-heuristics:** Introduction to Meta-heuristic search: Simulated Annealing (SA), Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Applications to real world optimization problems	**5**
Unit 5 **Matlab/Python Lib:** Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple	**7**

implementation of Artificial Neural Network and Fuzzy Logic	
Unit 6 Recent Trends in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.	**3**

COURSE OUTCOMES
After completion of course, students would be able to:
• Identify Soft Computing Techniques to handle real world decision and optimization problems.
• Apply soft computing to handle uncertainty, imprecision and solve various engineering problems.
• Evaluate and compare solutions by various soft computing approaches for a given problem.

References

1. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro-Fuzzy and Soft Computing®, Prentice-Hall of India, 2003.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications®, Prentice Hall, 1995.
3. Roy S., Chakraborty U, Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms, Pearson, 2013.
4. El-Ghazali Talbi, Meta-heuristics: From Design to Implementation, Wiley, 2009.
5. John Yen, Reza Langari, Fuzzy Logic: Intelligence, Control and Information, Pearson, 2007
6. MATLAB Toolkit Manual

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
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Course Code	PGCS203A
Course Name	Advances in DBMS
Credits	3
Pre-Requisites	Basic database concepts & exposure to any database package.

COURSE OBJECTIVE Total Number of Lectures: 36

- This module aims to give students in depth information about system implementation techniques, data storage, representing data elements, database system architecture, the system catalog, query processing and optimization, transaction processing concepts, concurrency control techniques, database recovery techniques, database security and authorization, enhanced data models for advanced applications, temporal databases, deductive databases, database technology for decision support systems, distributed databases and client server architecture, advanced database concepts, and emerging technologies and applications.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **Review of DBMS concepts & Relational Data Model:** Review of database concepts, Normal Forms, DBMS architecture, data modelling using ER and extended ER, data base access methods, static and dynamic hashing, indexing technique for files including B-Tree and B + tree data structures. The Relational model and Relational DBMS: integrity constraints, updation operations, operations of relational algebra, overview of the SQL language, Relational schema design. Relational calculus and an overview of the QBE language, Case study: Oracle/DB2/MS-SQL.	6
Unit 2: **Data Base Design:** DBMS system architecture; centralized and client server architecture; physical database design issues, Formalisms, normalization including functional and other types of dependencies and normal forms for relations, Multi-valued and join dependencies and 4NF, Join Dependency and 5NF, Inclusion Dependencies and Template Dependency, PJNF/DKNF, Techniques used for processing and optimizing queries specified in HL database log SQL query option.	6
Unit 3: **Transactions and Concurrency Control:** Anomalies in transactions, Serializable, recoverability, Concurrency Control, Two-phased locking and requirements to avoid all types of anomalies, lock-based time-stamp and validation based protocols, Distributed concurrency control, database failures and recovery, log-based, shadow paging, buffer management.	6

Unit 4: **Database Security and Authorization:** Database Security issues, Levels of database security, access control, Security mechanisms; multilevel database security; confidentiality and integrity requirements, Examples of e security.	**6**
Unit 5: **Distributed and Scalable Databases** Distributed database concepts, distributed DBMS architecture, distributed database design, top-down and bottom design, fragmentation, fragment allocation, Basic distributed query processing, transaction management in distributed database, distributed concurrency control, reliability issues in distributed DBMS. Big Data: concepts and alternative technologies -Map Reduce, Pig Latin	**6**
Unit 6: **Emerging Trends and Example DBMS Architectures:** Recent approaches, models and current trends in improving the performance of Database, 1. Multimedia database 2. Geography databases, Gnome databases 3. Spatial database 4. Mobile databases 5. Web databases (JDBC, ODBC) 6. Personal databases 7. Digital libraries 8. Data grids 9. Wireless networks and databases	**6**

COURSE OUTCOMES

After completion of course, students would be:

- Able to understand relational database management systems, normalization to make efficient retrieval from database and query. Apply normalization techniques. Understand how transactions are processed in a database. Discuss/explain the concepts of Distributed Databases and Data Warehousing. Discuss/explain some database security issues. Discuss/explain the different techniques in Concurrency Control. Tune and Optimize some Database Applications.

References:

1. Database System Concepts – Abraham Silberschatz, H F Korth and S Sudarshan, McGraw Hill.
2. Database Design and Relational Theory: Normal Forms and All That Jazz by C.J.Date
3. Fundamentals of Database Systems – 5th Edition by R.Elmasri, S. Navathe
4. Principles of Distributed Database Systems, Second Edition, M. Tamer Ozsu Patrick Valduriez, Prentice Hall
5. An Introduction to Database Systems – Date, C.J., Addison-Wesley
6. A First Course in Database Systems – Ullman, Jeffrey D.; Widom, Jennifer, Prentice Hall International, Inc.

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	**PGCS203B**
Course Name	**Artificial Intelligence**
Credits	**3**
Pre-Requisites	**Basic Mathematics, Computer Programming**

COURSE OBJECTIVES Total Number of Lectures: 36

• To introduce to the field of Artificial Intelligence (AI).
• To solve real world problems for which solutions are difficult to express using the traditional algorithmic approach.
• To explore the essential theory behind methodologies for developing systems that demonstrates intelligent behaviour including dealing with uncertainty.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Biological foundations to intelligent systems I: Artificial neural networks, Backpropagation networks, Radial basis function networks, and recurrent networks.	**7**
Unit 2: Biological foundations to intelligent systems II: Fuzzy logic, knowledge Representation and inference mechanism, genetic algorithm, and fuzzy neural networks.	**5**
Unit 3: Search Methods Basic concepts of graph and tree search. Three simple search methods: breadth-first search, depth-first search, iterative deepening search. Heuristic search methods: best-first search, admissible evaluation functions, hill climbing search. Adversarial search. Minimax search procedure, alpha-beta pruning. Optimisation and search such as stochastic annealing and genetic algorithm.	**7**

Unit 4: Knowledge representation and logical inference Issues in knowledge representation. Structured representation, such as frames, and scripts, semantic networks and conceptual graphs. Formal logic and logical inference. Knowledge-based systems structures, its basic components. Ideas of Blackboard architectures.	**7**
Unit 5: Reasoning under uncertainty and Learning Techniques on uncertainty reasoning such as Bayesian reasoning, Certainty factors and Dempster-Shafer Theory of Evidential reasoning, A study of different learning and evolutionary algorithms, such as statistical learning and induction learning.	**5**
Unit 6: Recent trends in Fuzzy logic, Knowledge Representation.	**5**

COURSE OUTCOMES

After completion of course, students would be able to:

1.	To demonstrate knowledge of the fundamental principles of intelligent systems.
2.	To analyse and compare the relative merits of a variety of AI problem solving techniques.
3.	To use different state-of-the-art machine learning techniques to solve real world problems.

References:

1. Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.
2. Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd edition.

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Course Code	Program Elective-III PGCS-203C/ PGSE-203D
Course Name	Object Oriented Software Engineering
Credits	3
Pre-Requisites	Basic knowledge of Object Oriented Design and Software Engineering

COURSE OBJECTIVES

Total Number of Lectures: 36

1.	To be able to fundamentally understand the Object Oriented Software Engineering concepts and terminology.
2.	To develop a full command of UML and its syntax and produce different UML models.
3.	To understand how a real world problem can be mapped to object oriented problem domain.
4.	To design and develop the solution of different industry level problems.

Syllabus:

MODULE1:

Introduction to object oriented systems, Classes, Objects, Characteristics of Objects, What is Object Oriented Development, Stages of Object Oriented Methodology, Differences from Functional Methodology, Object Modeling Technique: Object Model, Dynamic Model, Functional Model

MODULE 2

Object Modelling: Class and Object Diagrams, Links and Association, Aggregation- different types of aggregates, Generalization and Inheritance, Grouping Constructs, Abstract Class, Metadata, Class descriptors, Candidate Keys, Constraints

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MODULE 3

Elements of Object Model; Major Elements – Abstraction, Encapsulation, Modularity, Hierarchy; Minor Elements – Typing, Concurrency, Persistence; Message Passing, State, Behaviour and Identity of Object, Class Relationship and Object Relationship

MODULE 4

Unified Process (UP), UP phases: Inception, Elaboration, Construction and Transition, Unified Process Work Products, Agile Process, Principles behind the Agile manifesto, Characteristics of Agile Software development, Agile Process Models

MODULE 5

Introduction to UML, UML Goals and Scopes, Model, System, Architecture, Architectural Views, Use Cases and functional requirements, Identifying and writing Use Cases, Modelling a System's Logical Structure using Classes and Class Diagrams, Modelling a System's Behavioural view using Sequence Diagram, Collaboration Diagram, State Diagram, Modelling System Workflows using Activity Diagrams, Modelling a System's Implementation view using Component Diagram, Modelling a System's Environment view using Package diagram, Deployment Diagrams.

MODULE 6

UML Meta model: Design and Architectural Patterns.

LECTURE WITH BREAKUP	NO. OF LECTURES
MODULE 1: Introduction to object oriented systems, Classes, Objects,	**[3]**

Characteristics of Objects, What is Object Oriented Development, Stages of Object Oriented Methodology, Differences from Functional Methodology, Object Modeling Technique: Object Model, Dynamic Model, Functional Model**.**	
MODULE2 Object Modeling : Class and Object Diagrams, Links and Association, Aggregation- different types of aggregates, Generalization and Inheritance, Grouping Constructs, Abstract Class, Metadata, Class descriptors, Candidate Keys, Constraints.	**[4]**
MODULE 3 Elements of Object Model; Major Elements – Abstraction, Encapsulation, Modularity, Hierarchy; Minor Elements – Typing, Concurrency, Persistence; Message Passing, State, Behaviour and Identity of Object, Class Relationship and Object Relationship.	**[4]**
MODULE 4 Unified Process (UP), UP phases: Inception, Elaboration, Construction and Transition, Unified Process Work Products, Agile Process, Principles behind the Agile manifesto, Characteristics of Agile Software development, Agile Process Models.	**[4]**
MODULE 5 Introduction to UML, UML Goals and Scopes, Model, System, Architecture, Architectural Views, Use Cases and functional requirements, Identifying and writing Use Cases, Modeling a System's Logical Structure using Classes and Class Diagrams, Modeling a System's Behavioural view using Sequence Diagram, Collaboration Diagram, State Diagram, Modeling System Workflows using Activity Diagrams, Modeling a System's Implementation view using Component Diagram, Modeling a System's Environment view using Package diagram, Deployment Diagrams.	**[14]**

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MODULE 6 UML Meta model: Design and Architectural Patterns.	**[7]**

COURSE OUTCOMES

After completion of course, students would be able to:

CO1: Explain the core concepts of the object oriented methodology and object modelling.
CO2: Illustrate the different elements of the object models and clearly explain the Unified Process and Agile Process.
CO3: Exercise the specialised knowledge, skill and judgement needed to design and develop complex software systems using UML with the efficient utilization of Design and Architectural Patterns

Textbooks/References:

1. Object Oriented Modelling and Design – Rambaugh, James Michael, Blaha – Prentice Hall, India

2. Object Oriented System Development – Ali Bahrami – Mc Graw Hill

3. Object Oriented Analysis and Design with Applications, 2nd ed., Grady Booch, Redwood City, Calif: Benjamin Cummings, 1994

4. Object-Oriented Software Engineering, Ivar Jacobson, Addison Wesley, 1992, ISBN: 0201544350

5. The Unified Modeling Language Reference Manual, James Rumbaugh et. al., Addison Wesley, 1991, ISBN: 020130998X

6. The Unified Software Development Process , Ivar Jacobson et. al., Addison Wesley, 1999, ISBN: 0201571692

7. UML Distilled, Martin Fowler et. al., Addison Wesley, 1999, ISBN: 0201325632

8. Applying UML and Patterns: An Introduction to object-oriented Analysis and Design and iterative development, by Craig Larman, Pearson Education. (1998)

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Course Code	PGCS 203 D
Course Name	Secure Software Design & Enterprise Computing
Credits	
Pre-Requisites	

Course Objective Total Number of Lectures: 36

- To fix software flaws and bugs in various software.
- To make students aware of various issues like weak random number generation, information leakage, poor usability, and weak or no encryption on data traffic
- Techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.
- Methodologies and tools to design and develop secure software containing minimum vulnerabilities and flaws.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **Secure Software Design** Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, perform security testing and quality assurance.	**6**
Unit 2: **Enterprise Application Development** Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, develop components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution.	6
Unit 3: **Enterprise Systems Administration** Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, Monitor server resource utilization for system reliability and availability, Install and administer network services (DNS/DHCP/Terminal Services/Clustering/Web/Email).	**6**

Unit 4: Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to go about managing them.	**6**
Unit 5: Handle insecure exceptions and command/SQL injection, defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws.	**6**
Unit 6: Case study of DNS server, DHCP configuration and SQL injection attack.	**6**
Course Outcomes	
After completion of course, students would be:	
● Differentiate between various software vulnerabilities.	
● Software process vulnerabilities for an organization.	
● Monitor resources consumption in a software.	
● Interrelate security and software development process.	

References:

1. Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security, Addison Wesley.

Course Code	**PGCS-203E**
Course Name	**Computer Vision**
Credits	**3**
Pre-Requisites	**Linear algebra, vector calculus, Data structures and Programming.**

COURSE OBJECTIVE: Total Number of Lectures: 36

- Be familiar with both the theoretical and practical aspects of computing with images.
- Have described the foundation of image formation, measurement, and analysis.
- Understand the geometric relationships between 2D images and the 3D world.

LECTURE WITH BREAKUP	**NO. OF LECTURES**

Unit 1: Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis	**6**
Unit 2: Edge detection, Edge detection performance, Hough transform	**6**
Unit 3: Segmentation, Morphological filtering, Fourier transform	**6**
Unit 4: Feature extraction, shape, histogram, color, spectral, texture, using CVIP tools, Feature analysis, feature vectors, distance /similarity measures, data pre-Processing	**6**
Unit 5: Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi- supervised Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA, and Non-parametric methods.	**6**
Unit 6: Recent trends in Activity Recognition, computational photography, Biometrics.	**6**

COURSE OUTCOMES
After completion of course, students would be able to:
Developed the practical skills necessary to build computer vision applications.
To have gained exposure to object and scene recognition and categorization from images. Grasp the principles of state-of-the-art deep neural network

References:

1. Computer Vision: Algorithms and Applications by Richard Szeliski.
2. Digital Image Processing Third Edition Rafael C. Gonzalez Richard E. Woods
3. Deep Learning, by Goodfellow, Bengio, and Courville.
4. Dictionary of Computer Vision and Image Processing, by Fisher et al.

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	**Elective IV:** **PGCS-204A**
Course Name	**Human Computer Interaction**
Credits	**3**
Pre-Requisites	**Basic Mathematics**

COURSE OBJECTIVES Total Number of Lectures: 36

• Learn the foundations of Human Computer Interaction.
• Be familiar with the design technologies for individuals and persons with disabilities.
• Be aware of mobile Human Computer interaction.
• Learn the guidelines for user interface.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.	**6**
Unit 2: Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.	**9**
Unit 3: Cognitive models –Socio-Organizational issues and stake holder requirements – Communication and collaboration models-Hypertext, Multimedia and WWW.	**6**
Unit 4: Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.	**6**
Unit 5: Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.	6

Unit 6: Recent Trends: Speech Recognition and Translation, Multimodal System.	3

COURSE OUTCOMES

After completion of course, students would be able to:

1. Understand the structure of models and theories of human computer interaction and vision.
2. Design an interactive web interface on the basis of models studied.

References:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004 (UNIT I , II & III)
2. Brian Fling, "Mobile Design and Development", First Edition, O□Reilly Media Inc., 2009 (UNIT – IV)
3. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O□Reilly, 2009.(UNIT-V)

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Course Code	PGCS-204B
Course Name	Theory of Computation
Credits	3
Pre-Requisites	

Course Objective: Hrs.: 36

The goal of this course is to provide students with an understanding of basic concepts in the theory of computation. At the end of this course students will:

1. Be able to construct finite state machines and the equivalent regular expressions.
2. Be able to prove the equivalence of languages described by finite state machines and regular expressions.
3. Be able to construct pushdown automata and the equivalent context free grammars.
4. Be able to prove the equivalence of languages described by pushdown automata and context free grammars.
5. Be able to construct Turing machines and Post machines.
6. Be able to prove the equivalence of languages described by Turing machines and Post Machines Students will learn about a variety of issues in the mathematical development of computer science theory, particularly finite representations for languages and machines, as well as gain a more formal understanding of algorithms and procedures.

Models of Computation: 6

Models of computation - classification, properties and equivalences.

Languages & Automata Theory: 8

Chomsky Hierarchy of Grammars and the corresponding acceptors, Finite Representation of Languages, Properties of the Languages Accepted by Finite Automata – Finite Automata and Regular Expressions – Proofs those Languages Are and Are Not Regular, Free languages, Context-free grammars, formal definition of a Context-free grammar, Examples of context-free grammars, Designing context-free grammars, Ambiguity, Chomsky normal form, Pushdown Automata, Examples of pushdown Automata, Equivalence with context-free grammars, Non-context-free languages, The pumping lemma for context-free languages, Turing Machines, Recursive and Recursively Enumerable Languages; Operations on Languages, closures with respect to the operations.

Turing Machine: 8

Unsolvable Problems. Definition, notation and Example of Turing Machine (TM). Programming techniques computable languages and functions, Church Turing hypothesis, Universal TM, Random Access TM, Multi-tape TM, Equivalence of One-Tape and Multi-tape TM's, Nondeterministic TMs, Conversion of RE to TM, Multi-stack PDA & TM.

Computability and Decidability: 8

Church-Turing Thesis, Decision Problems, Decidability and un-decidability, unsolvable problems; Halting Problem of Turing Machines; Problem reduction (Turing and mapping reduction), Intractability (Hierarchy Theorems), Mapping reductions, More undecidable languages, Rice theory, Reductions using controlled executions, RE Completeness, Reductions using computation histories. Linear Bounded Automata, Unrestricted grammars.

Computational Complexity: 6

Resource-constrained computation. Time Complexity- notion of complexity classes, classes P NP, NP-complete, Boolean satisfiability, NP-Completeness of CSAT and 3SAT, NP- Hard, Cook, Levin Theorem. The concept of reduction, coNP, polynomial Hierarchy. Some natural NP-complete problems, Space Complexity-Savich's Theorem, The class PSPACE, Optimization, search, and decision problems, Approximate solutions to optimization problems.

BOOKS FOR STUDY:

TEXT BOOKS

1. J.E. Hopcroft, R. Motwani and J.D. Ullman, "Introduction to Automata Theory, Languages and Computations", second Edition, Pearson Education, 2007.
2. P, Linz, "An Introduction to Formal Languages and Automata" Forth Edition, Narosa Publication House.

REFERNCES

1. H.R. Lewis and C.H. Papadimitriou, "Elements of the theory of Computation", Second Edition, Pearson Education, 2003.
2. Thomas A. Sudkamp," An Introduction to the Theory of Computer Science, Languages and Machines", Third Edition, Pearson Education, 2007.
3. Raymond Greenlaw an H.James Hoover, " Fundamentals of Theory of Computation, Principles and Practice", Morgan Kaufmann Publishers, 1998.
4. Micheal Sipser, "Introduction of the Theory and Computation", Thomson Brokecole, 1997.
5. J. Martin, "Introduction to Languages and the Theory of computation" Third Edition, Tata Mc Graw Hill, 2007

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	Program Elective-IV PGCS-204C
Course Name	Cloud Computing
Credits	3
Pre-Requisites	Basic knowledge of Operating System, Distributed and Parallel Computing systems

COURSE OBJECTIVES Total Number of Lectures: 36

1.	Students should be able to understand the evolution of Cloud Computing from the existing technologies.
2.	To develop conceptual understanding of Cloud Computing and have knowledge on the various issues in Cloud Computing.
3.	To be familiar with the emerging technologies as the next generation computing paradigms.
4.	To understand how a real world problem can be mapped to the Cloud Computing domain and to solve different industry level problems.

Syllabus:

MODULE I

INTRODUCTION:

Introduction to Cloud Computing ; Definition of Cloud ; Evolution of Cloud Computing; Underlying Principles of Parallel and Distributed Computing; Parallel and Distributed Systems; Distributed Computing System Models – Minicomputer Model, Workstation Model, Workstation-Server Model, Processor-Pool Model, Hybrid Model; Network Operating Systems and Distributed Operating Systems; Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning; Conventional Computing vs. Cloud Computing; Benefits and Disadvantages of Cloud Computing

MODULE II

CLOUD ENABLING TECHNOLOGIES:

Service Oriented Architecture; Web Services; Publish-Subscribe Model; Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU –Memory – I/O Devices –Virtualization Support and Disaster Recovery.

MODULE III

CLOUD ARCHITECTURE, SERVICES:

Layered Cloud Architecture Design; NIST Cloud Computing Reference Architecture; Cloud Deployment Models: Public, Private, Community and Hybrid Clouds; Public Clouds vs. Private Clouds; Cloud Service Models : IaaS – PaaS – SaaS ; Architectural Design Challenges.

MODULE IV

RESOURCE MANAGEMENT, LOAD BALANCING AND TASK SCHEDULING:

Inter Cloud Resource Management; Resource Provisioning and Resource Provisioning Methods; Load Balancing in Cloud, Task Scheduling in Cloud Environment, VM Migration; Global Exchange of Cloud Resources.

MODULE V

SECURITY IN CLOUD:

Security Overview; Cloud Security Challenges; Cloud Forensics

MODULE VI

CLOUD TECHNOLOGIES AND ADVANCEMENTS:

Hadoop; MapReduce; Virtual Box; Google App Engine; Programming Environment for Google App Engine; Open Stack;

MODULE VII

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MOBILE CLOUD COMPUTING, FOG, EDGE AND DEW COMPUTING:

Offloading in MCC, Load balancing, Crowd sensing, Trust management in MCC; Architecture, Algorithm and application of Fog, Edge and Dew computing for IoT , IoV, AI based Mobile Edge computing; Challenges and Issues.

LECTURE WITH BREAKUP	NO. OF LECTURES
MODULE I **INTRODUCTION** Introduction to Cloud Computing ; Definition of Cloud ; Evolution of Cloud Computing; Underlying Principles of Parallel and Distributed Computing; Parallel and Distributed Systems; Distributed Computing System Models – Minicomputer Model, Workstation Model, Workstation-Server Model, Processor-Pool Model, Hybrid Model; Network Operating Systems and Distributed Operating Systems; Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning; Conventional Computing vs. Cloud Computing; Benefits and Disadvantages of Cloud Computing.	**[6]**
MODULE II **CLOUD ENABLING TECHNOLOGIES** Service Oriented Architecture; Web Services; Publish-Subscribe Model; Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU –Memory – I/O Devices – Virtualization Support and Disaster Recovery.	**[4]**
MODULE III **CLOUD ARCHITECTURE, SERVICES** Layered Cloud Architecture Design; NIST Cloud Computing Reference Architecture; Cloud Deployment Models: Public, Private, Community	**[6]**

and Hybrid Clouds; Public Clouds vs. Private Clouds ; Cloud Service Models : laaS – PaaS – SaaS ; Architectural Design Challenges.	
MODULE IV **RESOURCE MANAGEMENT, LOAD BALANCING AND TASK SCHEDULING** Inter Cloud Resource Management ; Resource Provisioning and Resource Provisioning Methods ; Load Balancing in Cloud, Task Scheduling in Cloud Environment, VM Migration; Global Exchange of Cloud Resources ;	**[5]**
MODULE V **SECURITY IN CLOUD** Security Overview ; Cloud Security Challenges ; Cloud Forensics	**[5]**
MODULE VI **CLOUD TECHNOLOGIES AND ADVANCEMENTS** Hadoop; MapReduce ; Virtual Box ; Google App Engine ; Programming Environment for Google App Engine ; Open Stack ;	**[2]**
MODULE VII **MOBILE CLOUD COMPUTING, FOG, EDGE AND DEW COMPUTING** Offloading in MCC, Load balancing, Crowd sensing, Trust management in MCC; Architecture, Algorithm and application of Fog, Edge and Dew computing for IoT , IoV, AI based Mobile Edge computing; Challenges and Issues.	**[8]**

COURSE OUTCOMES
After completion of course, students would be able to:
CO1: Explain the core concepts of the cloud computing paradigm: how and why this

paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing, Cloud Architecture and Enabling Technologies.
CO2: Illustrate the fundamental concepts of resource allocation, load balancing, task scheduling and security issues in Cloud Computing.
CO3: Learn about the Advances in Cloud Technologies and emerging areas of research.

Textbooks/References:

1. Anthony T.Velte, Toby J.Velte and Robert E, Cloud Computing – A Practical Approach, TMH 2010

2. Michael Miller, Cloud Computing – Web based Applications, Pearson Publishing, 2011

3. Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton, Publication Date: November 2, 2009

4. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice),Tim Mather, ISBN-10: 0596802765,O'Reilly Media, September 2009

Maulana Abul Kalam Azad University of Technology, West Bengal
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(Applicable from academic year 2019-20)

Course Code	**PGCS-203 E**
Course Name	**Network Security**
Credits	**3**
Pre-Requisites	**Computer Networks, Web Programming**

Course Objective

- To learn the basics of security and various types of security issues.
- To study different cryptography techniques available and various security attacks.
- Explore network security and how they are implemented in real world.
- To get an insight of various issues of Web security and biometric authentication.

LECTURE WITH BREAKUP	**NO. OF LECTURES (Total: 36)**
Unit 1: **Introduction to Computer Security** Need for security. Data security: Review of cryptography. Different types of attacks, Key range, Examples	**3**
Unit 2: **Symmetric Key and Asymmetric Key Cryptography-** Introduction, Algorithm, Modes, DES, AES, RSA, Digital Signature, Digital Certificate etc.	**5**
Unit 3: **Internet Security Protocols** Introduction, IP Level Security (IPSec), Transport Layer Security (TLS), SHTTP, SET, SSL, Application layer Security (PGP), 3D secure protocol, Email security, WAP Security (IEEE 802.11 security)	**5**
Unit 4: **User Authentication & Non repudiation** Authentication and–non repudiation basics, Passwords, Authentication tokens, Biometric Authentication, Kerberos KDC, Security Handshake Pitfalls, SSO, Attacks on Authentication schemes	5
Unit 5: **Network security, Firewalls and VPN** Introduction, Network security: Firewalls (Types Configuration), Proxy-Servers, Network intrusion detection, DMZ and VPN	**5**
Unit 6: **Web security** SQL injection, XSS, etc. Software security and buffer overflow. Malware types and case studies.	**5**
Unit 7: **Security in Wireless Networks, Internet of Things:** Attack models, protocols, applications	**4**
Unit 8: **Other Modern topics**: Intrusion Detection System (IDS), ECC, Basics of Cryptocurrency Block	**4**

Chain	
Course Outcomes	
After completion of course, students would be:	
● To have an understanding of basics of security and issues related to it.	
● Understanding of biometric techniques available and how they are used in today's world.	
● Security issues in web and how to tackle them.	
● Learn mechanisms for transport and network security	
● Learn security attacks, attack models, protocols, applications in Wireless networks, IoT.	

Text:

1. Cryptography and Network Security Practice and Principles: William Stallings Pearson 2020
2. Cryptography and Network Security- Atul Kahate : 4th Edition McGraw-Hill 2019
3. Cryptography and Network Security- Forouzan : 3rd edition McGraw-Hill

References:

1. W. R. Cheswick and S. M. Bellovin. Firewalls and Internet Security.
2. Wesley, 1994.2. W. Stallings. Cryptography and Network Security. Prentice Hall, 1999.
3. B. Schneier. Applied Cryptography. Wiley, 1999.
4. Cryptography and security: Shyamala, Harini, Padmabhabhan Wiley 2011

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Course Code	**PGCS-204E**
Course Name	**VLSI Design**
Credits	**3**
Pre-Requisites	**Digital Logic, Computer Organization and Design**

COURSE OBJECTIVES Total Number of Lectures: 36

• To provide rigorous foundation in MOS and CMOS digital circuits. • CMOS circuit characteristics and their performance. • To learn concepts of VLSI Design flow • To learn CMOS based static circuits and dynamic circuits, Delay analysis. • To learn how to design static and dynamic circuits by using different CMOS logic families.
• To expose the students with various design tools for Integrated Circuits and Chips 2. To teach the complete VLSI Design process and challenges ahead 3. Exposure to the designing for newer technologies • To make the students exposed to Front end and Back end VLSI CAD tools.
• To model combinational and sequential circuits using VHDL. • Generation of test vectors for combinational and sequential circuits • Automated and manual techniques for generating tests for faults in digital circuits and systems.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit1 Introduction to VLSI systems: A brief history, MOS Transistors, CMOS Logic, CMOS fabrication and lay out , VLSI design flow , fabrication, packaging and testing),VLSI Design Methodologies ,Introduction to VLSI Design methodologies	**5**
Unit 2 CMOS Circuit And Logic Design, CMOS Logic Gate Design, Basic Physical Design of Simple Gate, CMOS Logic Structures, Transmission gates, Static CMOS design, dynamic CMOS design. Low Power Design	**6**
Unit 3 Graph Algorithms, Logic Synthesis, High Level Synthesis, Compaction, Partitioning, Placement, Floorplanning, Pin Assignment, Global Routing, Detailed Routing	**6**

Unit 4 Introduction to VHDL: Computer-aided design, hardware description languages, VHDL description of combinational circuits, VHDL modules, sequential statements and VHDL processes, modeling flip-flops using VHDL processes, processes using wait statements, two types of VHDL delays: Transport and inertial delays, compilation, simulation, and synthesis of VHDL code, VHDL data types and operators, simple synthesis examples, VHDL models for multiplexers, VHDL libraries, modeling registers and counters using VHDL processes, behavioral and structural VHDL, variables, signals, and constants.	**8**
Unit 5 CMOS technologies: Layout design rules, CMOS process enhancement, Technology related CAD issues.	**5**
Unit 6 Role of testing in VLSI Design flow, testing at different levels of abstraction, Fault error, defect, diagnosis, yield, Types of testing, Rule of Ten, Defects in VLSI chip. CMOS stuck on/Open faults,Various types of faults, Fault equivalence and Fault dominance in combinational circuits. Combinational circuit test generation, Structural Vs Functional test, ATPG, Path sensitization methods, Boolean Difference method.	**6**

COURSE OUTCOMES

After completion of course, students would be able to:

● Implement the logic circuits using MOS and CMOS technology. ● Design low power CMOS VLSI circuits. ● Understand the rapid advances in CMOS Technology
● At the end of the course, student will know the different stages of design flow; the basic data structures and algorithms used in each stage; and will be able to understand data structures and algorithms used in recent CAD tools; choose suitable data structures and propose new algorithms for CAD applications and develop new CAD tools ● Execute the special features of VLSI back end and front end CAD tools and UNIX shell script
● Understand the basics of VHDL. ● Develop VHDL models of combinational and sequential logic circuits.
● Students will be knowledgeable in • principles of testing digital systems. • design for testability in combinational and sequential circuits. • basics of self-test and fault diagnosis.

References:

1. Sung-Mo Kang, CMOS Digital Integrated Circuits, 3rd Edition, McGraw-Hill, 2003.
2. P.K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002.
3. M. Abramovici, M. Breuer, and A. Friedman, “Digital Systems Testing and Testable Design, IEEE Press, 1990.
4. Charles Roth, Digital Systems Design using VHDL, 2/e, Cengage Learning, 2012.

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Course Code	PGCS-292
Course Name	Advances in Algorithm
Credits	2
Pre-Requisites	

Lab assignments

Language used: Python/C

1. Quick Sort, Randomized Quick Sort
2. Binary Tree, Heap sort
3. Merge sort
4. Kruskal Algorithm
5. Prims Algorithm
6. Breadth-first search (BFS)
7. Depth First Search (DFS)
8. Dijkstra's Algorithm
9. Longest Common Subsequence (LCS)
10. Floyd-Warshall Algorithm
11. Matrix Chain Multiplication
12. Ford-Fulkerson Algorithm
13. Simplex Algorithm
14. DFT
15. FFT

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Course Code	**PGCS-293A**
Course Name	**Laboratory for Advances in DBMS**
Credits	**2**
Pre-Requisites	**Basic database concepts & exposure to any database package.**

COURSE OBJECTIVE Total Number of Lectures: 36P

- To explore the features of a Database Management Systems
- To interface a database with front end tools
- To understand the internals of a database system

LECTURE WITH BREAKUP	NO. OF LECTURES
• Basic SQL • Intermediate SQL • Advanced SQL	**6**
• ER Modeling • Database Design and Normalization	**6**
• Accessing Databases from Programs using JDBC • Building Web Applications using PHP & MySQL	**6**
• Indexing and Query Processing • Query Evaluation Plans • Concurrency and Transactions	**6**
• Practice on Normalization – using any database perform various normal forms. • Practice on transaction processing	**6**
o Big Data Analytics using Hadoop	**6**

COURSE OUTCOMES

After completion of course, students would be:

- Ability to use databases for building web applications.
- Gaining knowledge about the internals of a database system.

References:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", 6th edition, Tata McGraw Hill, 2011
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 4th Edition, Pearson/Addision wesley, 2007
3. Sql/Pl Bayross, Ivan BPB

Maulana Abul Kalam Azad University of Technology, West Bengal
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Course Code	**PGCS-293B**
Course Name	**Artificial Intelligence Lab**
Credits	**2**
Pre-Requisites	**Basic Knowledge about Coding**

COURSE OBJECTIVES Total Number of Lectures: 36P

• To understand how to draw logical inferences.
• To solve uncertain real-world problems using fuzzy sets.
• To explore foundations of neural networks.
• To deal with optimization problems using genetic algorithms.

LECTURE WITH BREAKUP
Unit 1: Basic Understanding of Prolog Programming to infer logical conclusions.
Unit 2: Write a program in MATLAB to plot various membership functions. Use Fuzzy toolbox to model tip value based on service and food quality. Implement FIS Editor.
Unit 3: Generate AND, NOT function using McCulloch-Pitts neural net by MATLAB program. Write a MATLAB program for Perceptron net for an AND function with bipolar inputs and targets.
Unit 4: Write a MATLAB Program on Basic Operations of Genetic Algorithm.

COURSE OUTCOMES

After completion of course, students would be able to:

1. To demonstrate knowledge of the fundamental principles of first order logic.
2. To analyse uncertainties using fuzzy logic.
3. To use different neural networks to classify different patterns.
4. To implement optimization using genetic algorithms.

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Course Code	**Laboratory IV (from Elective-III)** **PGCS-293C**
Course Name	**Object Oriented Software Engineering** **Practical**
Credits	**2**
Pre-Requisites	**Basic knowledge of Object Oriented Design and Software Engineering**

COURSE OBJECTIVES Total Number of Lectures: 36P

1.	To be able to fundamentally understand the Object Oriented Software Engineering concepts and terminology.
2.	To develop a full command of UML and its syntax and produce different UML models.
3.	To understand how a real world problem can be mapped to object oriented problem domain.
4.	To design and develop the solution of different industry level problems.

Syllabus

Design and develop different models using OMT notation and UML for systems and implement those systems:

1. Design a Library Management System following the Object Oriented approach using UML and implement the system.
2. Design a Hospital Management System following the Object Oriented approach using UML and implement the system.
3. Design a Rail Reservation System following the Object Oriented approach using UML and implement the system.
4. Design a Hotel Booking System following the Object Oriented approach using UML and implement the system.
5. Design an Online Shopping System following the Object Oriented approach using UML and implement the system.
6. Design a Flight Reservation System following the Object Oriented approach using UML

and implement the system.
7. Design an Online Examination System following the Object Oriented approach using UML and implement the system.

COURSE OUTCOMES
After completion of course, students would be able to:
CO1: Understand the object oriented approach of software development.
CO2: Learn about proper object oriented software engineering principles while focussing on the reusability concept.
CO3: Exercise the specialised knowledge, skill and judgement needed for the object oriented design and development of complex software systems using UML.

References:

1. Object Oriented Modelling and Design – Rambaugh, James Michael, Blaha – Prentice Hall, India

2. Object Oriented System Development – Ali Bahrami – Mc Graw Hill

3. Object Oriented Analysis and Design with Applications, 2nd ed., Grady Booch, Redwood City, Calif: Benjamin Cummings, 1994

4. Object-Oriented Software Engineering, Ivar Jacobson, Addison Wesley, 1992, ISBN: 0201544350

5. The Unified Modeling Language Reference Manual , James Rumbaugh et. al., Addison Wesley, 1991, ISBN: 020130998X

6. The Unified Software Development Process , Ivar Jacobson et. al., Addison Wesley, 1999, ISBN: 0201571692

7. UML Distilled, Martin Fowler et. al., Addison Wesley, 1999, ISBN: 0201325632

8. Applying UML and Patterns: An Introduction to object-oriented Analysis and Design and iterative development, by Craig Larman, Pearson Education. (1998)

9. The complete reference-Java2 – Patrick Naughton, Herbert Schildt – TMH

10. Core Java For Beginners – R.K Das – VIKAS PUBLISHING

11. Java How to Program – 6th Ed.– Deitel and Deitel – Pearson

12. Beginning Java 2 SDK – Ivor Horton -Wrox

13. Programming With Java: A Primer – 3rd Ed. – E. Balagurusamy – TMH

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Course Code	Elective III PGCS-293 D
Course Name	Secure Software Design & Enterprise Computing Laboratory IV
Credits	2
Pre-Requisites	Software Engineering, Security fundamentals

1. Security programming practices, Security testing techniques implementation. [9P]

2. Design and implementation of a directory-based server infrastructure in a heterogeneous systems environment. [9P]

3. Security techniques to protect system against SQL injection attack, Secure mobile application development etc. [9P]

4. Simulation tools to design and develop secure software [9P]

Reference

1. https://www.us-cert.gov/bsi/articles/knowledge/sdlc-process/secure-software-development-life-cycle-processes

2. Practical Enterprise Software Development Techniques: Tools and Techniques for Large Scale Solutions, by Edward Crook shanks

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Course Code	**PGCS-293E**
Course Name	**Computer Vision**
Credits	**2**
Pre-Requisites	**Basic knowledge of Image Processing & Matrix operations**

Total Number of Lectures: 36P

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1 Implementation of Basic Matrix operation & image reading & writing	**3**
Unit 2 Implementation of different pre-processing & Edge detection algorithms	**6**
Unit 3 Implementation of Segmentation algorithms &Morphological filtering	**9**
Unit 4 Implementation of Feature extraction algorithms	**9**
Unit 5 Feature reduction & classification using Weka tool	**9**

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
(Applicable from academic year 2019-20)

Course Code	Elective – V PGCS-301A
Course Name	Natural Language Processing
Credits	3
L-T-P	3-0-0
Pre-Requisites	

Course Objective **Total Number of Lectures: 36**

This course is about a variety of ways to represent human languages as computational systems, and how to exploit those representations to write programs that do useful things with text and data, like translation, extraction information.

LECTURES WITH BREAKUP	NO. OF LECTURES
Unit 1: Introduction NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Brief history of the field.	5
Unit 2: N-gram Language Models - The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models.	5
Unit 3: Part Of Speech Tagging and Sequence Labelling - Lexical syntax. Hidden Markov Models (Forward and Viterbi algorithms and EM training).	5
Unit 4: Syntactic parsing - Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs.	5
Unit 5: Semantic Analysis - Chapters 18-20. Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labelling and Semantic Parsing.	5
Unit 6: Information Extraction (IE) **-** Named entity recognition and relation extraction. IE using sequence labelling.	5
Unit 7: Machine Translation (MT) - Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.	6

Course Outcomes

After completion of the course, students would be able to:

- Identify and automatically pre-process texts that can be useful for language processing tasks.
- Devise and evaluate solutions for a range of natural language components like POS tagging, parsing and semantic role labeling.

• Extraction of information from a given text.
• Know how to use statistical and phrase-based methods for machine translation.

References:

1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009
2. Bharati A., Sangal R., Chaitanya V. Natural Language Processing: A Paninian Perspective, PHI, 2000
3. James A. Natural Language Understanding 2e, Pearson Education, 1994

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
(Applicable from academic year 2019-20)

Course Code	PGCS-301B
Course Name	Bioinformatics
Credits	3
Pre-Requisites	Design & of Analysis of Algorithms, Data Structure, Machine Learning

COURSE OBJECTIVES Total Number of Lectures:36

- To provide the basic knowledge of molecular biology, interdisciplinary knowledge required in bioinformatics to the students having background in computer science and engineering
- To make the students familiar with the use of a wide variety of biological databases/structures and to enable them to extract relevant information using appropriate algorithms
- To equip the students with computational intelligence techniques so that they are able to do research in computational biology and R&D in biotechnological industry and medicine.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **Introduction to Molecular Biology** Basic Concepts and structures of DNA, RNA, genes and Protein, Transcription, Translation and Protein Synthesis, Gene Expression, Gene Regulatory Network	3
Unit 2: **Introduction to Bio-informatics:** Data Storage and maintenance, Protein Sequence, DNA sequence databases. Gene Expression Data, Database search programs like BLAST and FASTA. NCBI different modules: GenBank; OMIM, Taxonomy browser, PubMed; Biological Classification and Nomenclature.	4
Unit 3: **Genomics** Sequence Alignment: Introduction, local and global alignment, pair wise and multiple alignment, Dynamic Programming Concept. Alignment algorithms, Identification of Transcription Factors, Gene Expression Data, CDNA and affimatrix technique for generating Gene Expression Data, Clustering	5
Unit 4: **Proteomics** Protein Sequence Data Analysis, Structures, Predicting secondary and	6

tertiary structures, Algorithms for structure prediction, Prediction of functions from structures	
Unit 5: **Models and Algorithms:** Molecular Phylogenetics, Phylogenetic Trees, Algorithms for Phylogenetic Tree Construction, Needleman Wunch algorithm; Scoring Matrices - Matrices for Nucleic Acid and Protein Sequences; Hidden Markov Model, Bayesian Model: Architecture, Principle, Applications	**6**

Unit 6: **Computational Intelligence in Bioinformatics:** Gene Expression Data Analysis; Clustering, Classification, Normalization and Principal Component Analysis, Decision, kNN and K-Means Algorithm, Gene Regulatory Network Reconstruction – Baysean Net, Neural Network Model; Metaheuristics and Clustering, Application to Biclustering, Gene selection and Pathway analysis.	**12**

COURSE OUTCOMES
After completion of the course
• The students will be able to describe the contents and properties of the most important bioinformatics databases. • The students will learn problem specific as well as general solution methods from different domains like mathematics, statistics and computer science • The students will demonstrate the ability to apply various concepts, principles of bioinformatics and algorithms to real life biological problems.

References:

1. D. E. Krane and M. L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 2003.Dan Gasfield: Algorithms on Strings, Trees and Sequences, Computer Science and Computational Biology, Cambridge University Press.
2. M. S. Waterman: Introduction to Computational Biology: Maps, Sequences and Genomes, 1995.
3. N.C. Jones and P. A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT, Press, 2004.
4. R. Durbin, S. Eddy, A. Krog, G. Mitchison, Biological sequence analysis: probabilistic models of proteins and nuclic acids, Cambridge University Press, 1998.
5. S C Rastogi, N Mendiratta, P Rastogi, Bioinformatics methods and applications genomics, proteomics and drug discovery, PhHI Learning Pvt. Ltd.
6. Y. Zhang & J. C. Rajapakse, (Eds.). (2009). Machine learning in bioinformatics (Vol. 4, p. 0470397411). Hoboken: Wiley.

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Course Code	**Elective V** **PGCS-301 C**
Course Name	**IoT and its security, Program**
Credits	**3**
Pre-Requisites	**Wireless Networks, Cryptography & Network Security**

Course Objectives: Total Number of Lectures: 36

- Extensive and detailed overview of relevant topics on Wireless Sensor Network, Sensors, Cloud, Smart Applications etc. to provide with the fundamental concepts and knowledge building related to emerging technology.
- Architecture, Algorithms, Applications and Security issues and challenges of Interne of Things technology.
- Enables students to get acquainted with practical IoT based smart application development interfaced with other required disciplines such as hardware, embedded Operating system, Database, intelligent algorithms such as ML, AI etc.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **General Overview:** IoT and cyber-physical systems, IoT security (vulnerabilities, attacks, and countermeasures), security engineering for IoT development, IoT security lifecycle.	**3**
Unit 2: **Architecture and Applications:** Smart transportation, smart cities, smart living, smart energy, smart health etc.: architecture, functioning, privacy, security	**6**
Unit 3: **Protocols:** Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases.	**6**
Unit 4: **Vulnerabilities, Attacks, and Countermeasures & Security Engineering for IoT Development:** Threats, vulnerability, and risks, Today's IoT attacks, Security in agile developments, Focusing on the IoT device in operation, Safety and security design, Processes and agreements, Technology selection – security products and services	**6**
Unit 5: **The IoT Security Lifecycle: The secure IoT system**	**6**

implementation lifecycle: Operations and maintenance, Implementation and integration, Dispose	
Unit 6: **Cryptographic Fundamentals for IoT Security Engineering:** Types and uses of cryptographic primitives in the IoT, Encryption and decryption, Hashes, Digital signatures, Cryptographic module principles, Cryptographic key management fundamentals, Examining cryptographic controls for IoT protocols, Future directions of the IoT and cryptography.	**6**
Unit 7: Identity, Access, Privacy Management Solutions for the IoT: An introduction to identity and access management for the IoT, the identity lifecycle, Authentication credentials, IoT IAM infrastructure, Authorization and access control, Privacy challenges introduced by the IoT.	**3**
Outcome:	
At the end this course students will be able to learn followings:	
● High quality works highlighting security issues,	
● Explain the state-of-the-art methodologies in security	
● Model threats and countermeasures	
● Discuss corresponding case studies in areas of IoT, cloud computing and software-defined networks.	

References:

1. B. Rusell and D. Van Duren, "Practical Internet of Things Security," Packt Publishing, 2016.

2. A. Narayanan et al., "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction," Princeton University Press, 2016.

3. A. Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies," O'Reilly, 2014.5.T. Alpcan and T. Basar, "Network Security: A Decision and Game-theoretic Approach," Cambridge University Press, 2011.

4. Mandler, B., Barja, J., Mitre Campista, M.E., Cagá ová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
(Applicable from academic year 2019-20)

Course Code	Program Elective-IV PGCS-301D
Course Name	Digital Forensics
Credits	3
Pre-Requisites	Cybercrime, Computer Networks, Network Security, Cloud Computing

COURSE OBJECTIVES

Total Number of Lectures: 36

1.	Provides an in-depth study of the rapidly changing and fascinating field of digital forensics.
2.	Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
3.	Knowledge on E-evidence collection and preservation, digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation
4.	Knowledge on Network Forensics, Mobile Forensics, IoT Forensics, Cloud Forensics

Syllabus:

MODULE I

INTRODUCTION

Introduction to Computer Forensics: - Definition of Computer Forensics and Its Importance; Computer Forensics Vs. Computer Security; History of Digital forensics; What is digital data – types of data, sources of data; Preservation of evidence; General Challenges posed by digital evidence; Guidelines for successful computer forensics; Tasks of a Computer Forensics Specialist; Issues faced by computer forensics examiners

MODULE II

DIGITAL FORENSICS

Objectives of Digital forensics; Process of Digital forensics; Types of Digital Forensics; Challenges faced by Digital Forensics; Advantages of Digital forensics; Disadvantages of Digital Forensics; Chain of Custody; Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008.

MODULE III

CYBER CRIME INVESTIGATION TOOLS AND TECHNIQUES

What is a cybercrime investigation; Who conducts cybercrime investigations; Cybercrime investigation techniques; cybercrime investigation and forensic tools;

The Nature of Digital Evidence; Types of Digital Evidence; Extraction Techniques; Seizing Electronic Evidence - Principles; How Digital Devices Are Collected; Digital Evidence preservation; Authority for Seizing Evidence; Crimes and Digital Evidence.

MODULE IV

ELECTRONIC CRIME SCENE INVESTIGATION

Handling Digital Evidence at the Scene; Electronic Devices: Types, Description, and Potential Evidence; Investigative Tools and Equipment; Securing and Evaluating the Scene; Documenting the Scene; Evidence Collection; Packaging, Transportation and Storage of Digital Evidence; Electronic Crime and Digital Evidence Considerations by Crime Category.

MODULE V

NETWORK FORENSICS

Introduction to Network Forensics; Handling Evidence; Cryptographic Hashes; Chain of Custody; Incident Response; The Need for Network Forensic Practitioners; Short introduction to some well-known tools - Packet capturing tools: tcpdump, dumpcap, a simple pattern matching

engine: ngrep; A flow capture & analysis tool: Argus, Network intrusion detection system example: Snort, The full-scale analysis tool: Wireshark

MODULE VI

MOBILE FORENSICS

Importance of Mobile Forensics; Types of evidence; Mobile Forensics Process; Non-invasive vs. Invasive Forensics; Tools & Techniques commonly Used in Mobile Forensics

MODULE VII

IoT FORENSICS

Digital Forensics and IoT Forensics; Why and where do we need IoT Forensics; IoT Forensics Challenges; IoT Forensics Approaches & Frameworks; Open issues in the IoT Forensics

MODULE VIII

CLOUD FORENSICS

Cloud Forensics: What is it? Digital Forensics and Cloud Forensics, Dimensions involved in Cloud Forensics; Digital Forensics in Cloud Environment; Cloud Forensics Challenges; Opportunities of Cloud Forensics.

LECTURE WITH BREAKUP	NO. OF LECTURES
MODULE I **INTRODUCTION** Introduction to Computer Forensics: - Definition of Computer Forensics and Its Importance; Computer Forensics Vs. Computer Security; History of Digital forensics; What is digital data – types of data, sources of data; Preservation of evidence; General Challenges posed by digital evidence; Guidelines for successful computer forensics; Tasks of a Computer Forensics Specialist; Issues faced by computer forensics examiners	**[5]**

MODULE II **DIGITAL FORENSICS** Objectives of Digital forensics; Process of Digital forensics; Types of Digital Forensics; Challenges faced by Digital Forensics; Advantages of Digital forensics; Disadvantages of Digital Forensics; Chain of Custody; Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008.	**[4]**
MODULE III **CYBER CRIME INVESTIGATION TOOLS AND TECHNIQUES** What is a cybercrime investigation; Who conducts cybercrime investigations; Cybercrime investigation techniques; cybercrime investigation and forensic tools; The Nature of Digital Evidence; Types of Digital Evidence; Extraction Techniques; Seizing Electronic Evidence - Principles; How Digital Devices are Collected; Digital Evidence preservation; Authority for Seizing Evidence; Crimes and Digital Evidence;	**[4]**
MODULE IV **ELECTRONIC CRIME SCENE INVESTIGATION** Handling Digital Evidence at the Scene; Electronic Devices: Types, Description, and Potential Evidence; Investigative Tools and Equipment; Securing and Evaluating the Scene; Documenting the Scene; Evidence Collection; Packaging, Transportation and Storage of Digital Evidence; Electronic Crime and Digital Evidence Considerations by Crime Category	**[6]**
MODULE V **NETWORK FORENSICS** Introduction to Network Forensics; Handling Evidence;	**[4]**

Cryptographic Hashes; Chain of Custody; Incident Response; The Need for Network Forensic Practitioners; Short introduction to some well-known tools - Packet capturing tools: tcpdump, dumpcap, A simple pattern matching engine: ngrep; A flow capture & analysis tool: Argus, Network intrusion detection system example: Snort, The full-scale analysis tool: Wireshark	
MODULE VI **MOBILE FORENSICS** Importance of Mobile Forensics; Types of evidence; Mobile Forensics Process; Non-invasive vs. Invasive Forensics; Tools & Techniques commonly Used in Mobile Forensics	**[4]**
MODULE VII **IoT FORENSICS** Digital Forensics and IoT Forensics; Why and where do we need IoT Forensics; IoT Forensics Challenges; IoT Forensics Approaches & Frameworks; Open issues in the IoT Forensics	**[4]**
MODULE VIII **CLOUD FORENSICS** Cloud Forensics: What is it? Digital Forensics and Cloud Forensics, Dimensions involved in Cloud Forensics; Digital Forensics in Cloud Environment; Cloud Forensics Challenges; Opportunities of Cloud Forensics	**[5]**

COURSE OUTCOMES
After completion of course, students would be able to:
CO1: Analyse the various mechanism of computer forensics.
CO2: Employ various computer tools and processes to investigate cyber-crime scene

CO3: Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation

Text Books:

1. Computer Forensics and cybercrimes: An introduction by Marjie T. Britz, Pearson Education, India.2013
2. Investigating the Cyber Breach: The digital forensics guide for the network engineer by Joseph Muniz and Aamir Lakhani, Pearson Education India.2018

Reference Books:

1. John Sammons, The Basics of Digital Forensics, Elsevier, 2014.
2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications, 2015.
3. Bayuk, J. (2010). CyberForensics: Understanding information security investigations. Springer Science & Business Media.
4. Casey, E. (2009). Handbook of digital forensics and investigation. Academic Press.
5. Casey, E. (2011). Digital evidence and computer crime: Forensic science, computers and the internet. Academic Press.
6. EC-Council. (2016). Computer forensics: Investigating network intrusions and cybercrime (CHFI). Cengage Learning.
7. Holt, T. J., Bossler, A. M., & Seigfried-Spellar, K. C. (2015). Cybercrime and digital forensics: An introduction. Routledge.
8. Nelson, B., Phillips, A., & Steuart, C. (2014). Guide to computer forensics and investigations. Cengage Learning.
9. Rajaraman, V. (2008). Computer basics and C programming. PHI Learning Pvt.
10. Robertazzi, T. (2011). Basics of computer networking. Springer Science & Business Media.

11. Santanam, R., Sethumadhavan, M., & Virendra, M. (2010). Cyber security, cybercrime and cyber forensics: Applications and perspectives: Applications and perspectives. IGI Global.

12. Wempen, F. (2014). Computing fundamentals: Introduction to computers. John Wiley & Sons.

Course Code	**PGCS-301E**
Course Name	**Advances in Compiler Design**
Credits	**3**
L-T-P	**3-0-0**
Pre-Requisites	**Compiler Design and Programming Concepts**

Course Objective Total Number of Lectures: 36

The aim of the course is to give thorough knowledge on advanced topics in designing compilers, like control-flow analysis, data-flow analysis, instruction scheduling, optimization and pipelining. This course also helps to do research work.

LECTURES WITH BREAKUP	NO. OF LECTURES
Unit 1: Overview of Compilation	**3**
Unit 2: Control Flow and Data Flow Analysis – Basic Blocks, Loops, Dominators, Post-Dominators, Control Dependence, Reaching definition, Live variable Analysis, Forward and Backward Problems, Available Expressions, General Data Flow Analysis	**8**
Unit 3: Instruction Scheduling – Local Instruction Scheduling: List Scheduling Algorithm, Architectural Complications, Beyond Basic Blocks	**8**
Unit 4: Transformation for the Memory Hierarchy – Registers vs Caches, Loops and Locality: Temporal and Spatial Locality, Scalar Replacement and Register Pressure, Loop Unrolling, Unroll-and-Jam and Tiling in Scientific Codes	**7**
Unit 5: Pipelining and Scheduling – Loop Scheduling without resource bound, Resource-bounded loop pipelining, Branch Prediction	**6**
Unit 6: Case Studies of Compilers and Recent Trends	**4**

Course Outcomes

After completion of the course, students would be able to:

- Analyse the control structure and runtime flow of values in the program.

• Explain instruction selection mechanism.
• Use different code optimization techniques.
• Design modern compilers.

References:

1. Keith Cooper and Linda Torezon, Engineering A Compiler, Morgan-Kaufman Publishers, 2nd Ed
2. A. Aho, M. Lam, R. Sethi and J. Ullman, Complilers: Principles, Techniques and Tools, Pearson
3. S. Muchnick, Advanced Compiler Design and Implementation, Morgan-Kaufman Publishers
4. Andrew Appel, Modern Compiler Implementation in C, Cambridge University Press, Revised Edition
5. Randy Allen & Ken Kennedy, Optimizing Compilers for Modern Architectures, Morgan Kaufmann
6. Michael Wolfe, High Performance Compilers for Parallel Computing, , Addison-Wesley

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
(Applicable from academic year 2019-20)

Course Code	Open Elective: PGCS-302A
Course Name	A: Business Analytics
Credits	
L-T-P	
Pre-Requisites	

Course objective Total Number of Lectures: 36

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

LECTURE WITH BREAKUP	LECTURES (hrs)
Unit 1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	6
Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	6
Unit 3: Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	6
Unit 4: Software-Defined	6

Networks: Introduction of Software-Defined Networks, Security for Software-Defined Networks, Privacy Leakages for Software-Defined Networks, Case Studies: How to Attack Software-Defined Network	
Unit 5: Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model. Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	**6**
Unit 6: Recent Trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	**6**
COURSE OUTCOMES:	
At the end this course students will be able to learn followings:	
● Students will demonstrate knowledge of data analytics.	
● Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.	
● Students will demonstrate the ability to use technical skills in predicative and prescriptive modelling to support business decision-making.	
● Students will demonstrate the ability to translate data into clear, actionable insights.	

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

2. Business Analytics by James Evans, persons Education.

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
(Applicable from academic year 2019-20)

Course Code	PGCS-302B
Course Name	Operations Research
Credits	3
L-T-P	3-0-0
Pre-Requisites	

Course Objective Total Number of Lectures: 36

The aim of the course is to build capabilities in the students to analyse different situations in the industrial and business scenario involving limited resources and to find the optimal solution within the constraints.	
LECTURES WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	**6**
Unit 2: Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	**7**
Unit 3: Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT	**7**
Unit 4: Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	**8**
Unit 5: Competitive Models, Single and Multi-Channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	**8**
Course Outcomes	
After completion of the course, students would be able to:	
● Apply the dynamic programming to solve problems of discreet and continuous variables.	
● Apply the concept of non-linear programming.	
● Carry out sensitivity analysis.	
● Model the real world problem and simulate it.	

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Maulana Abul Kalam Azad University of Technology, West Bengal
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(Applicable from academic year 2019-20)

Course Code	PGCS-302C
Course Name	Cost Management of Engineering Projects
Credits	3
L-T-P	3-0-0
Pre-Requisites	

Lecture: - 3 h/week, Total Lecture: 36

Syllabus:

Introduction and Overview of the Strategic Cost Management Process. Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Project:

Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.

Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram.

Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology- Computer Science & Engineering
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Course Code	Open Elective: PGCS-302D
Course Name	D: Industrial Safety
Credits	3
L-T-P	3-0-0
Pre-Requisites	Basic Engineering Systems Engineering Chemistry and Engineering Physics

Course objective Total Number of Lectures: 36

The student should be made to:

- Be exposed to the basic rudiments of the Industrial Safety
- To understand the modelling aspects behind Industrial Safety
- To understand why industrial safety is required
- Be exposed to different Industrial Safety methods

LECTURE WITH BREAKUP	LECTURES (hrs)
Unit 1: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/ procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc. Safety color codes. Fire prevention and firefighting, equipment and methods.	6
Unit 2: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	6
Unit 3: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, Model Curriculum of Engineering & Technology PG Courses [Volume-I] [37] principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	8
Unit 4:	8

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	
Unit 5: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/ procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.	**8**

COURSE OUTCOMES:
At the end this course students will be able to learn followings:
• Explain the fundamentals of Industrial Safety.
• Link data mining with business intelligence.
• Apply various modeling techniques related to Industrial Safety.
• Explain the different delivery process related to Industrial Safety.

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Maulana Abul Kalam Azad University of Technology, West Bengal
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(Applicable from academic year 2019-20)

Course Code	Open Elective: PGCS-302E
Course Name	E: Composite Materials
Credits	3
L-T-P	3-0-0
Pre-Requisites	

Total Number of Lectures: 36

LECTURE WITH BREAKUP	LECTURES (hrs)
Unit 1: **INTRODUCTION:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance. .	**6**
Unit 2: **REINFORCEMENTS:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.	**8**
Unit 3: **Manufacturing of Metal Matrix Composites:** Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.	**7**
Unit 4: **Manufacturing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.	**7**
Unit 5:	**8**

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.	

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

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Course Code	**PGCS-302F**
Course Name	**Waste to Wealth**
Credits	**3**
Pre-Requisites	**Renewable Energy Sources, Physics, Environmental studies**

Total No. of Lectures: 36

COURSE OBJECTIVE

- To classify solid waste sources.
- To identify methods of solid waste disposal.
- To study various energy generation methods
- To analyze biogas production methods and recycling of e-waste.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1 **Solid Waste Sources-** Solid waste sources**,** types**,** composition**,** properties**,** Global warming**,** Municipal Solid Waste**:** Physical**,** Chemical and biological properties**,** waste collection and**,** transfer stations**,** waste minimization and recycling of municipal waste**,** segregation of waste**,** size reduction**,** managing waste**.** Status of biotechnologies for generation of Energy from waste treatment and Disposal Aerobi compositing**,** incineration**,** furnace type and design**,** medical waste**/**pharmaceutical waste treatment technologies**,** incineration**,** Environmental impacts**,** measures to mitigate environmental effects due **to** incineration**.**	**6**
Unit 2 **Land Fill method of Solid waste disposal:** Land fill classification, types, methods and sitting consideration, layout and preliminary design of landfills: composition, characteristics, generation, movement and control of landfill leach ate and gases, Environmental monitoring system for land fill gases.	**6**

Unit 3 **Energy Generation from waste Bio-chemical convention:** Sources of energy generation, anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, Anaerobic Digestion.	**8**
Unit 4 Biogas production, Land fill gas generation and utilization, Thermo-chemical convention: Sources of energy generation, Gasification of waste using Gasifiers, Briquetting, Utilization and advantages of briquetting, Environmental benefits of Bio- chemical and Thermo-chemical convention.	**8**
Unit 5 E-waste: e-waste in the global content- Growth of Electrical and Electronics Industry in India- Environmental concerns and health hazard – Recycling e-waste: a thriving economy of the unorganized sector – Global trade in hazardous waste – impact of hazardous e-waste in India. Management of e-waste: e-waste legislation, Government regulations on e-waste management – International experience- need for stringent health safeguards and environmental protection laws of India.	**8**
COURSE OUTCOMES	
After completion of course, students would be able to:	
• Understand technologies for generation of energy from solid waste.	
• Compare methods of solid waste disposal.	
• Identify sources of energy from bio-chemical convention. • Analyse methods for management of e-waste.	

Text Books:

1. Nicholas p. Cheremisinoff, Handbook of Solid Waste Management and Waste Minimization Technologies. An In print of Elsevier, New Delhi (2003).
2. P. Aarne veiling, William A. Nortel and Debra R. Reinhart, Solid Waste Engineering, Thomson Asia Pte Ltd. Singapore (2002).
3. M. Dutta, B.P. Parida, B.K Guha and T.R. Surkrishnan, Industrial Solid Waste Management and Landfilling practice, Narousa Publishing House, New Delhi (1999).
4. "E-waste in India: Research unit, Raiya Sabha Secretariat, New Delhi (1999).
5. Amalendu Bagchi, Design, construction and Monitoring of Landfills, John Wiley and sons, New York (1994).
6. C. S Rao, Environmental Pollution Control Engineering, Wiley Eastern Ltd. New Delhi (1995).

7. M. L. Davis and D.A. Cornwell, Introduction to environmental engineering, Mc Graw Hill International Edition, Singapore (2008).
8. Sofer, Samir S.(ed), Zaborsky, R. (ed), "Biomass convention process for Energy and Fuels", New York, Plenum Press, (1981).
9. S.K Agarwal, Industrial Environment Assessment and Strategy, APH Publishing Corporation New Delhi (1996).

References:

1. C Parker and T Roberts (Ed), Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
2. KL Shah, Basics of Solid and Hazardous Waste Management Technology, Prentice Hall, 2000 3. M Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997
3. G Rich et.al, Hazardous Waste Management Technology, Podvan Publishers,1987

Google Books:

1. e-waste Management: From waste to Resource Klaus Hieronymi, Ramzy kahnat, Eric Williams, Technology and Engineering-2013 publisher: Earthscan 2013.
2. E-waste poses a Health Hazard: Sairudeen Pattazhy.
3. What is the impact of E-waste: Tamara Thompson.

Web links:

1. www.unep.org
2. www.routledge.com

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Audit course 1 & 2: to be selected from following subjects

Course Code	Audit Course I(A)
Course Name	ENGLISH FOR RESEARCH PAPER WRITING
Credits	0
Pre-Requisites	

COURSE OBJECTIVES Total Number of Lectures: 12

● Understand that how to improve your writing skills and level of readability
● Learn about what to write in each section
● Understand the skills needed when writing a Title
● Ensure the good quality of paper at very first-time submission

LECTUREWITHBREAKUP	NO. OF LECTURES
Unit 1: Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	2
Unit 2: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.	2
Unit 3: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	2
Unit 4: Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	2
Unit 5: Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	2
Unit 6: Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission	2

References

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

3. Highman N (1998), Hand book of Writing for the Mathematical Sciences, SIAM. Highman's book.

4. Adrian Wall work, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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Course Code	**Audit Course I(B)**
Course Name	**PEDAGOGY STUDIES**
Credits	**0**
Pre-Requisites	

COURSE OBJECTIVES Total Number of Lectures: 12

• Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
• Identify critical evidence gaps to guide the development.

LECTURE WITHB REAKUP	NO. OF LECTURES
Unit 1: **Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.	**2**
Unit 2: **Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.	**2**
Unit 3: **Evidence on the effectiveness of pedagogical practices:** Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices.	**3**

Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.	
Unit 4: **Professional development:** Alignment with classroom practices and follow-up support Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes	**3**
Unit 5: **Research gaps and future directions:** Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.	**2**

COURSE OUTCOMES

Students will be able to:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Reference

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

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Course Code	Audit Course I(C)
Course Name	CONSTITUTION OF INDIA
Credits	0
Pre-Requisites	

COURSE OBJECTIVES Total Number of Lectures: 12

Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **History of Making of the Indian Constitution:** History, Drafting Committee, (Composition & Working)	2
Unit 2: **Philosophy of the Indian Constitution:** Preamble Salient Features	2
Unit 3: **Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality Right to Freedom Right against Exploitation Right to Freedom of Religion Cultural and Educational Rights Right to Constitutional Remedies Directive Principles of State Policy Fundamental Duties.	2

Unit 4: **Organs of Governance:** Parliament Composition Qualifications and Disqualifications Powers and Functions Executive President Governor Council of Ministers Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions	**2**
Unit 5: **Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	**2**
Unit 6: **Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	**2**

COURSE OUTCOMES

Students will be able to

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of

the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Reference

1. The Constitution of India, 1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B.R.Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M.P.Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D.Basu, Introduction to the Constitution of India, LexisNexis, 2015.

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Course Code	Audit Course I(D)
Course Name	DISASTER MANAGEMENT
Credits	0
Pre-Requisites	

COURSE OBJECTIVES Total Number of Lectures: 12

• Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
• Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
• Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **Introduction:** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	2
Unit 2: **Repercussions of Disasters and Hazards:** Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	2
Unit 3: **Disaster Prone Areas in India:** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.	2
Unit 4: **Disaster Preparedness and Management:**	2

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	
Unit 5: **Risk Assessment:** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.	**2**
Unit 6: **Disaster Mitigation:** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation In India.	**2**

References

1. R. Nishith, Singh A K, "Disaster Management in India: Perspectives, issues and strategies' New Royal book Company.

2. Sahni, Pardeep Et.Al.(Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

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Course Code	**Audit Course I(E)**
Course Name	**VALUE EDUCATION**
Credits	**0**
Pre-Requisites	

COURSE OBJECTIVES Total Number of Lectures: 12

• Understand value of education and self-development
• Imbibe good values in students
• Let the should know about the importance of character

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Values and self-development:** Social values and individual attitudes. Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles and Value judgments.	**3**
Unit 2: **Importance of cultivation of values:** Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline	**3**
Unit 3: **Personality and Behaviour Development:** Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits.	**3**

Association and Cooperation. Doing best for saving nature	
Unit 4: **Character and Competence:** Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence,Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively	**3**

COURSE OUTCOMES

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

Reference

1. Chakroborty, S. K. "Values andEthics for organizations Theory and practice", Oxford University Press, New Delhi.

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Course Code	Audit Course I(F)
Course Name	STRESS MANAGEMENT BY YOGA
Credits	0
Pre-Requisites	

COURSE OBJECTIVES

Total Number of Lectures: 12

- To achieve overall health of body and mind
- To overcome stress

LECTURE WITHB REAKUP	NO. OF LECTURES
Unit 1: Definitions of Eight parts of yog. (Ashtanga)	4
Unit 2: **Yam and Niyam:** Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	4
Unit 3: **Asan and Pranayam:** Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam	4

COURSEOUTCOMES

Students will be able to

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Reference

1. 'Yogic A sanas for Group Tarining-Part-I":Janardan Swami Yogabhyasi Mandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department),Kolkata

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Course Code	Audit Course I (G)
Course Name	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS
Credits	0
Pre-Requisites	

COURSE OBJECTIVES Total Number of Lectures: 12

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

LECTUREWITHBREAKUP	NO. OF LECTURES
Unit 1: **Neetisatakam-Holistic development of personality:** Verses- 19,20,21,22 (wisdom) Verses- 29,31,32 (pride & heroism) Verses- 26,28,63,65 (virtue) Verses- 52,53,59 (dont's) Verses- 71,73,75,78 (do's)	4
Unit 2: **Approach to day to day work and duties:** Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.	4
Unit 3: **Statements of basic knowledge:** Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63	4

COURSEOUTCOMES

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

Reference

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

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Course Code	Audit Course I(H)
Course Name	SANSKRIT FOR TECHNICAL KNOWLEDGE
Credits	0
Pre-Requisites	

COURSE OBJECTIVES

Total Number of Lectures: 12

● To get a working knowledge in illustrious Sanskrit, the scientific language in the world
● Learning of Sanskrit to improve brain functioning
● Learning of Sanskrit to develop the logic in mathematics, science & other subjects
● enhancing the memory power
● The engineering scholars equipped with Sanskrit will be able to explore the
● huge knowledge from ancient literature

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Alphabets in Sanskrit, Past/Present/Future Tense, simple Sentences	4
Unit 2: Order, Introduction of roots, Technical information about Sanskrit Literature	4
Unit 3: Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	4

COURSEOUTCOMES

Students will be able to

● Understanding basic Sanskrit language
● Ancient Sanskrit literature about science & technology can be understood
● Being a logical language will help to develop logic in students

Reference

1. "Abhyaspustakam"– Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition "Suresh Soni, Ocean books(P)Ltd., New Delhi.