DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
COMILLA UNIVERSITY
CUMILLA, BANGLADESH

SYLLABUS FOR M. Sc. (Engg.) IN COMPUTER SCIENCE AND ENGINEERING
SESSION: 2020-2021, 2021-2022, 2022-2023

Department of Computer Science and Engineering
Comilla University
Kotbari, Cumilla 3506

Courses for MS Program in CSE
[Master of Science (Engineering) in Computer Science and Engineering]

Syllabus for Master of Science (Engineering) program in Computer Science and Engineering for the students who are admitted in the academic session 2020-2021, 2021-2022 and 2022-2023.

The Following two categories of MS Programs in Computer Science and Engineering are offered by the department:

Categories	Group Name
Master of Science with Thesis	Group A
Master of Science with Project	Group B

The MS Program courses in computer Science and Engineering shall extend over period of one academic year and shall be divided into two semesters: first semester and second semester. One semester will extend for a period of 6 months including classes, preparation leave, examination and result processing. For the purpose of assessment, 100 marks will be assigned to 3 credit courses. Each laboratory course will be assigned 100 marks for evaluation. Semester-wise credit distributions for two categories are tabulated in the following table:

Group A:

Semester No	Course Type	No. of Courses	Credit
1st Semester	Theoretical	04	12
	Practical	00	
	Thesis Part-I	01	06
2nd Semester	Theoretical	02	06
	Practical	00	
	Thesis Part-II	Continuation of Part I	12
		Total	**36**

Group B:

Semester No	Course Type	No. of Courses	Credit
1st Semester	Theoretical	04	12
	Practical	03	03
2nd Semester	Theoretical	04	12
	Practical	04	04
	Project Work	01	05
		Total	**36**

Eligibility for Admission:
CGPA 3.50 or more in his/her undergraduate level of study is allowed to take admission in any group. A candidate having CGPA less than 3.50 is only allowed to be admitted in group B.

The distribution of courses and credits will be as follows:

1st Semester					
Sl.	**Course No**	**Course Title**	**Hrs/ week**	**Credit Hrs**	**Marks**
Option-I		**Students will opt for 01 one course (Group A and Group B)**			
1	CSE 5101	Software Testing & Quality Assurance	3	3	100
2	CSE 5102	Research Methodology	3	3	100
Option-II		***Students from Group A will opt for 03 (Three) theoretical courses only. *Students from Group B will opt for 06 (Eight) courses (Theoretical = 3 + Laboratory = 3).**			
Sl.	**Course No**	**Course Title**	**Hrs/week**	**Credit Hrs**	**Marks**
1	CSE 5103	Computer Vision	3	3	100
2	CSE 5104	Computer Vision Lab	2	1	100
3	CSE 5105	Natural Language Processing	3	3	100
4	CSE 5106	Natural Language Processing Lab	2	1	100
5	CSE 5107	Bioinformatics	3	3	100
6	CSE 5108	Bioinformatics LAB	2	1	100
7	CSE 5109	Embedded Systems	3	3	100
8	CSE 5110	Embedded Systems Lab	2	1	100
9	CSE 5111	Deep Learning	3	3	100
10	CSE 5112	Deep Learning Lab	2	1	100
11	CSE 5113	Introduction to Data Science	3	3	100
12	CSE 5114	Data Science Lab	2	1	100
13	CSE 5115	Database Administration	3	3	100
14	CSE 5116	Database Administration Lab	2	1	100
15	CSE 5117	Web Technologies	3	3	100
16	CSE 5118	Web Technologies Lab	2	1	100
Applicable only for group A students					
CSE 5100T		Thesis-Part-I	12	6	300

2nd Semester					
Compulsory Course					
Option-III		***Students from Group A will opt for 2 (Two) theoretical courses only. *Students from Group B will opt for 08 (Eight) courses (Theoretical=4+ Laboratory=4).**			
Sl.	**Course No**	**Course Title**	**Hrs/ week**	**Credit Hrs**	**Marks**
1	CSE 5201	Robotics Technology	3	3	100
2	CSE 5202	Robotics Technology LAB	2	1	100
3	CSE 5203	Computational Intelligence	3	3	100
4	CSE 5204	Computational Intelligence Lab	2	1	100
5	CSE 5205	Mobile and Wireless Communication	3	3	100
6	CSE 5206	Mobile and Wireless Communication Lab	2	1	100
7	CSE 5207	Data Mining	3	3	100

Sl.	Course No	Course Title	Hrs/ week	Credit Hrs	Marks
8	CSE 5208	Data Mining Lab	2	1	100
9	CSE 5209	Semantic Web Technologies	3	3	100
10	CSE 5210	Semantic Web Technologies Lab	2	1	100
11	CSE 5211	Cloud Computing	3	3	100
12	CSE 5212	Cloud Computing Lab	2	1	100
13	CSE 5213	Graph Theory and Computational Geometry	3	3	100
14	CSE 5214	Graph Theory and Computational Geometry Lab	2	1	100
15	CSE 5215	Block Chain Technology	3	3	100
16	CSE 5216	Block Chain Technology LAB	2	1	100
17	CSE 5217	Mobile Application and Game Development	3	3	100
18	CSE 5218	Mobile Application and Game Development Lab	2	1	100
19	CSE 5219	Software Maintenance and Evolution	3	3	100
20	CSE 5220	Software Maintenance and Evolution Lab	2	1	100
Thesis/Project					
CSE 5200T		Thesis part-II(Only for group A)		12	600
CSE 5200P		Project Work (Only for group B)		05	200

Syllabus in Detail

First Semester

CSE 5101: Software Testing & Quality Assurance
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- This course explores the goals of quality assurance and quality control activities performed during the life cycle of a software product.
- It focuses on integrating test processes with agile software development methodologies. Practical exercises give experience of design, specification, execution of tests plus test automation using tools through a mixture of instructor-directed exercises and student research leading to knowledge sharing.
- Will also be able to understand why majority of the software projects fails
- How that failure probability can be reduced effectively.
- Will be able to do the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques

Course Contents

Software Testing: Introduction to software testing, Inspection, Static analysis, Unit testing, Integration and system testing, Regression testing, Functional testing, Structural testing, Test case selection, Testing of object-oriented software, Performance testing, Security testing, Web application testing, Graphical user interface (GUI) testing, Usability testing, Fault-based testing, Test automation and tools, Planning and monitoring the software quality process.
Software Quality Assurance: Introduction to Software Quality, Quality Assurance, The uniqueness of Software Quality Assurance, Software Quality Factors, Development Plans and Quality Plans, Integrating Quality Activities in the Project Life Cycle, Reviews.

Reference Books:

1. Software Testing and Analysis: Process, Principles and Techniques, by Mauro Pezze and Michal Young, John Wiley & Sons
2. The Art of Software Testing, Second Edition by Glenford J. Myers et. al.
3. Software Engineering: A Practitioner's Approach, Roger S Pressman, McGraw-Hill. Chapters 13 and 14.
4. Software Quality Assurance- from theory to implementation, By: Daniel Galin, Publisher: Pearson Education

CSE 5102: Research Methodology
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To explain what research is and what it is not, and the different definitions of research;
- To introduce the objectives of research, and set the motivation in research;

- To present some aspects of the debate about the nature of knowledge and the value of scientific method; and
- To discuss the criteria of good research and the different types of research.

Course Contents

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process
Problem Identification & Formulation: Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance
Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses.
Experimental Design: Concept of Independent & Dependent variables.
Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.
Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.
Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
Interpretation of Data and Paper Writing: Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.
Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.
Research Ethics

Reference Books:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari.
4. Select references from the Internet.

CSE 5103: Computer Vision
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To develop understanding of the basic principles and techniques of image processing and image understanding, and to develop your skills in the design and implementation of computer vision software.
- To introduce students the fundamentals of image formation;
- To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition;

- To develop an appreciation for various issues in the design of computer vision and object recognition systems; and
- To provide the student with programming experience from implementing computer vision and object recognition applications.

Course Contents

Introduction: What is computer vision, why is it difficult, background, human vision, application areas.
Image formation: geometry and photometry
Geometry, brightness, quantization, camera calibration, photometry (brightness and color)
Image segmentation: Region segmentation, Edge and line finding
Image processing: Edge detection, corner detection, line and curve detection, SIFT operator, image-based modeling and rendering, mosaics, snakes.
Multi-view Geometry: Shape from stereo and motion, feature matching, surface fitting, Active ranging
Image classification: Pixel classification, region classification, face detection and identification
Object Recognition: Model-based methods, appearance-based methods, invariants
Motion analysis: Motion detection and tracking, optical flow, inference of human activity from image sequences

References:

1.	D. A. Forsyth, J. Ponce	:	**Computer Vision: A Modern Approach,** *Prentice Hall*
2.	R. Szeliki	:	**Computer Vision: Algorithms and Applications,** *publisher : Springer, 2010, Draft available online (http://*szeliski*.org/Book)*
3.	V. S. Nalwa	:	**A Guided Tour of Computer Vision,** *Addison-Wesley,1993*
4.	R. Hartley and Zisserman	:	**Multiple View Geometry in Computer Vision,** *Cambridge University Press, ISBN: 0521540518, 2nd edition, 2004*
5.	Rafael Gonzalez and Richard Woods		**Digital Image Processing,** *Addison-wesley, 3rd edition*

CSE 5104: Computer Vision Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5103.

CSE 5105: Natural Language Processing
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To extract information from text automatically using concepts and methods from natural language processing (NLP) including stemming, n-grams, POS tagging, and parsing.
- To develop speech-based applications that use speech analysis (phonetics, speech recognition, and synthesis).
- To analyze the syntax, semantics, and pragmatics of a statement written in a natural language.

- To develop a conversational agent that uses natural language understanding and generation.
- To apply machine learning algorithms to natural language processing.
- To write scripts and applications in Python to carry out natural language processing using libraries such as NLTK, Gensim, and spaCY.
- To design NLP-based AI systems for question answering, text summarization, and machine translation.
- To evaluate the performance of NLP tools and systems.

Course Contents

Introduction; Word Modeling: Automata and Linguistics, Statistical Approaches and Part of Speech Tagging; Linguistics and Grammars; Parsing Algorithms; Parsing Algorithms and the Lexicon; Semantic; Feature Parsing; Tree Banks and Probabilistic Parsing**;** Machine Translation; Evolutionary Models of Language Learning and Origins**.**

References:

1. Daniel Jurafsky, and James H. Martin : Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, *Prentice Hall*.

2. Christopher D. Manning, and Hinrich Schtze : Foundations of Statistical Natural Language Processing, *The MIT Press*.

CSE 5106: Natural Language Processing Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5105.

CSE 5107: Bioinformatics
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To gain knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
- Use existing software effectively to extract information from large databases and to use this information in computer modeling
- Develop problem-solving skills, including the ability to develop new algorithms and analysis methods
- To understand the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries

Course Contents

Introduction to the genome: DNA, RNA, amino acids, and proteins; Information flow from the genome: genes, transcription, and translation; Integration of biological data: data integration systems, biological queries, query processing, data warehouses, and data visualization; Genome and protein sequencing and analysis, spectrum graphs; Clustering and classification: miocroarrays, gene expression analysis, hierarchical clustering, k-means clustering, clustering and classification algorithms; Drug discovery: technologies and strategies, identification of drug target molecules, drug design approaches.

Books Recommended:

1. *An Introduction to Bioinformatics Algorithms*, by Neil C. Jones and Pavel A. Pevzner, MIT Press, 1st Edition, 2004, [We will follow this book, collect it. Indian Edition should be available at Nilkhet (try "Memory Books")]
2. *Computational Molecular Biology: An Algorithmic Approach*, by Pavel A. Pevzner, MIT Press, 1st Edition, 2000.

CSE 5108: Bioinformatics Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5107.

CSE 5109: Embedded Systems
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To perform effectively as entry level Embedded Systems professionals.
- To develop and maintain applications written using Embedded C.
- To independently design and develop a hardware platform encompassing a microcontroller and peripherals.

Course Contents

Introduction to Embedded System: Components of Embedded System, Classification, Characteristic of embedded system, Microprocessors & Micro controllers, Introduction to embedded processors, embedded software architectures.

Review of Hardware*:* Advanced hardware, timing diagrams, memory, memory selection for embedded system, DMA, interrupts, interrupt and shared data problem, interrupt latency, The CAN bus, and the USB bus, parallel bus protocol, the PCI Bus and GPIB bus, device drivers, serial and/parallel port device drivers.

Software architectures, Round Robin, Function queues scheduling architecture, real time operating system architecture. Embedded program modeling concepts in single and multiprocessor systems, software development process, software engineering practices in the embedded software development process.

Real Time operating System (RTOS): Intercrosses communications and synchronization of process, tasks

and thread, shared memory, memory locking, memory allocation, signals, semaphore flag, message queues mailboxes, pipes, virtual Sockets. Task, task state, RTOS task scheduling models, context switching and interrupt handing, priority resonation technique, priority inversion, performance metric in scheduling models.

Software Development: Embedded Programming in C and C++, Source Code engineering tools for embedded C/C++. Embedded Programming in Java. Study of Micro C/OS-II

Hardware description using VHDL/Verilog HDL: Language fundamentals, Gate level, Dataflow and behavioral model, timing controls, block assignments, description of combinational and sequential logic circuits using HDL.

Microcontroller programming: Architecture of microcontroller of 8051 family, programming model, register, instruction set, enhanced 8051 features, architecture – introduction to 8 bit and 16 bit microcontrollers, 32 Bit microcontrollers: ARM 2 TDMI core based 32 Bit microcontrollers, register, memory and data transfer application design.

References:

1. Raj Kamal : **Embedded System: Architecture, Programming and Design**, *Tata McGraw-Hill*
2. David E Simon : **An Embedded Software Premier,** *Pearson Education Asia*
3. Samir Palnitkar : **Verilopg HDL,** *Pearson*
4. Douglas Perry : **VHDL,** *Tata McGraw Hill Edition*
5. Kenneth J. Ayata : **The 8051 Microcontroller,** *Thomson and Delmar Learning*
6. Myke Predko : **Programming and Customizing 8051 Microcontroller,** *McGraw-Hill*
7. Steve Heath : **Embedded Systems Design, Newnes**
8. Sriram Iyer and Pankaj Gupta : **Embedded Real Time Systems Programming, Tata McGraw-Hill**
9. Tammy Noergaard : **Embedded System Architecture, Elsevier India Private Limited**

CSE 5110: Embedded Systems Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5109.

CSE 5111: Deep Learning
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.
- To identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
- To implement deep learning algorithms and solve real-world problems.

Course Contents

Introduction: Various paradigms of earning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques.
Feedforward neural network: Artificial Neural Network, activation function, multi-layer neural network.
Training Neural Network: Risk minimization, loss function, back-propagation, regularization, model selection, and optimization.
Conditional Random Fields: Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy.
Deep Learning: Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network.
Probabilistic Neural Network: Hopfield Net, Boltzman machine, RBMs, Sigmoid net, Auto encoders.
Deep Learning research: Object recognition, sparse coding, computer vision, natural language processing.
Deep Learning Tools: Caffe, Theano, Torch.

Text Books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016..
2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.

Reference Books
1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

CSE 5112: Deep Learning Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5111.

CSE 5113: Introduction to Data Science
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To acquire data through web-scraping and data APIs
- To clean and reshape messy datasets
- To use exploratory tools such as clustering and visualization tools to analyze data
- To perform linear regression analysis
- To use methods such as logistic regression, nearest neighbors, decision trees, support vector machines, and neural networks to build a classifier
- To apply dimensionality reduction tools such as principle component analysis
- To perform basic analysis of network data
- To evaluate outcomes and make decisions based on data
- To effectively communicate results

Course Contents

Introduction to Data Science, Mathematical and Statistical Skills, Machine Learning, Artificial Intelligence, Coding, Applied Mathematics and Informatics, Machine Learning Algorithms, Data Warehousing, Data Mining, Data Visualization, Cloud Computing, Data Structures, Scientific Computing, Scholastic Models, Project Deployment Tools, Predictive Analytics and Segmentation, Exploratory Data Analysis, Big Data

Reference Books:

1. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, by Wes McKinney, 2nd edition
2. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, by Aurélien Géron
3. Data Science from Scratch: First Principles with Python, by Joel Grus

CSE 5114: Data Science Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5113.

CSE 5115: Database Administration
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To fully understand the concepts and technical issues of database administration.
- To develop understanding of internal functionality of DBMS.
- To perform database administration tasks like backup and recovery and performance tuning of databases.

Course Contents

Survey advanced topics in database systems. Distributed databases, Query processing, Transaction processing. Distributed DBMS Architecture: Client-server and peer-to-peer systems, Distributed Database Design, Semantic Integrity Control in DDBMS. Effects of data models; object oriented and deductive data management for emerging areas; internet applications, data mining. Case studies of existing systems, Group projects. Object oriented database, Object relational database, Complex data types, Querying with complex data types, Levels of distribution transparency, Translation of global queries to fragment queries, Query optimization, Optimization of access strategies, Management of distributed transactions, Concurrency control, Reliability Administration, Parallel database, Different types of parallelism, Design of parallel database, Multimedia database systems; Basic concepts, Design, Optimization an of access strategies, Management of Multimedia database, distributed database, heterogeneous database, decision support, OLAP, digital Libraries, Database, decision support, OLAP, digital Libraries, Database Wire-housing/data mining: Basic concepts and algorithms Export databases: use of rules of deduction in databases, recursive rules, Fuzzy database: fuzzy set and fuzzy logic, use of fuzzy techniques to define inexact and incomplete databases.

Reference Books:

1. Student Guides for Oracle Database Administration. Year/Edition: 2010 Aug, Title: Oracle Database 11g: Administration Workshop 1 (Volume 1 and 2)
2. Principles of Distributes Database System, M. Tamer Ozsu and Patric Valdureiz, 2nd Edition.
3. Database Design, Application Development, and Administration by Michael V. Mannino
4. Fundamentals of Database Sustems, Fifth Edition, by elmasri/Navathe, published by Addison-wesley, 2007.

CSE 5116: Database Administration Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5115.

CSE 5117: Web Technologies
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To develop a dynamic webpage by the use of java script and DHTML.
- To write a well formed / valid XML document.
- To connect a java program to a DBMS and perform insert, update and delete operations on DBMS table.
- To write a server side java application called Servlet to catch form data sent from client, process it and store it on database.
- To write a server side java application called JSP to catch form data sent from client and store it on database.

Course Contents

Introduction to HTML: HTML Common tags- Block Level and Inline Elements, Lists, Tables, Images, Forms, Frames; Cascading Style sheets, CSS Properties;

Java Script: Introduction to Java Script, Objects in Java Script, Dynamic HTML with Java Script

JDBC: Data Base, Database Schema, A Brief Overview Of The JDBC Process, JDBC Driver Types, JDBC Packages, Database Connection, Associating The JDBC-ODBC Bridge With Database, Creating, Inserting, Updating And Deleting Data In Database Tables, Result Set, Metadata.

Web Servers and Servlets: Tomcat web server, Introduction to Servlets: Servlets, the Advantage of Servlets over "Traditional" CGI, Basic Servlet Structure, Simple Servlet Generating Plain Text, Compiling and Installing the Servlet, Invoking the Servlet, Lifecycle of a Servlet, The Servlet API, Reading Servlet parameters, Reading Initialization parameters, Context Parameters, Handling Http Request & Responses, Using Cookies-Session Tracking, Servlet with JDBC.

Introduction to JSP: The Problem with Servlet. The Anatomy of a JSP Page, JSP Processing, JSP Application Development: Generating Dynamic Content, Using Scripting Elements, Implicit JSP Objects, Declaring Variables and Methods, Sharing Data Between JSP pages, Users Passing Control and Data between Pages, JSP application design with JDBC, JSP Application Design with MVC.

Introduction to PHP: Basics of PHP, Functions, Error Handling, Interaction between PHP and MySQL, Database using Forms, Using PHP to manipulate and Retrieve Data in MySQL.

TEXT BOOKS:

1. Jon Duckett "Beginning Web Programming" WROX.
2. Marty Hall and Larry Brown "Core Servlets and Java Server pages Vol. 1: Core Technologies", Pearson.

REFERENCE BOOKS:

1. DanWoods and Gautam Guliani,"Open Source for the Enterprise: Managing Risks, Reaping Rewards", O'Reilly, Shroff Publishers and Distributors, 2005.
2. Sebesta,"Programming World Wide Web", Pearson.
3. Dietel and Nieto, "Internet and World Wide Web – How to program", PHI/Pearson Education Asia.
4. Murach, "Murach's beginning JAVA JDK 5", SPD
5. Wang, "An Introduction to web Design and Programming", Thomson

CSE 5118: Web Technologies Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5117.

Second Semester

CSE 5201: Robotics Technology
Credits: 3
Contact: 3 Hours/Week

Course Objectives:

- To provide an introduction to Robotics and Automation including robot classification, design and selection, analysis and applications in industry.
- To provide information on various types of end effectors, their design, interfacing and selection.
- To provide the details of operations for a variety of sensory devices that are used on robot , the meaning of sensing, classification of sensor, that measure position, velocity & acceleration of robot joint.
- To familiarize the basic concepts of transformations performed by robot.
- To perform kinematics and to gain knowledge on programming of robots.

Course Contents

Introduction*:* History, robot architectures, technical concepts of robotics, computing and robots, actuation and sensing, robotic system design, applications.
Coordinate systems: Cartesian coordinates transformation matrices, reference frames, relative and general transformations, orientation, inverse transformations, graphs.
Rigid-Body Dynamics, Mobile Robots, Personal Assistants, and Games
Kinematics position: Joints, members, reference frames, trigonometric solution, Homogeneous transformations, direct and inverse kinematics, orientation, precision, efficiency/complexity of kinematics solutions.
Kinematics motion: Derivatives, velocity and acceleration of a rigid bodies, differential movement, Jacobian, and singularities.
Sensors, measurements and perception: Sensors hierarchy, Dynamic Systems, Sensors and Actuators, interfaces, internal and external sensors, location, computer vision, applications. Structure of robot brain programs. Input statements. Basic repetition structures: timed, forever, and counting. Sensing from within: Proprioception in the Scribbler: battery, stall, and time sensing. Examples of behaviors using proprioception. Loops with conditions: comparison operations and logical connectives in Python.
Sensing the world: camera, light, and proximity. Writing reactive behaviors: making decisions in Python. Sensing light and obstacles.
Control: Basic concepts in control systems, digital control for position, Behavior-based control. Dynamic Effects of Feedback Control, Analog and Digital Control Systems, Optimal Control, Least-Squares Estimation and Numerical Optimization, Monte Carlo Evaluation and Evolutionary Algorithms, Formal Logic and Computing, Predicate Calculus; 1st-order Logic, and Fuzzy Sets,
Probability and Statistics, Multivariate Statistics and Stochastic Control, Stochastic, Robust, and Adaptive Control, Classification of Data Sets, Introduction to Neural Networks, Training Neural Networks, Machine Learning and Knowledge Representation, Task Planning and Multi-Agent Systems
System design: System integration: mechanism, actuators and sensors, and software, Designing insect-like behaviors, Braitenberg vehicles, making decisions, Designing reactive behaviors. Other examples: refrigerator detective, burglar alarm robot

References:

1. Robert F. Stengel : **Robotics and Intelligent Systems: A Virtual Textbook**, Princeton University, Princeton, NJ, *2012.*

CSE 5202: Robotics Technology Lab

Credits: 1

Contact: 2 Hours/Week

This laboratory course is based on CSE 5201.

CSE 5203: Computational Intelligence

Credits: 3

Contact: 3 Hours/Week

Course Objectives

- To provide the theoretical and practical knowledge necessary for students to be able to efficiently design and implement intelligent systems within the field of Computational Intelligence.
- Specifically, students will acquire the basic concepts of neural computing, evolutionary computing and fuzzy computing.

Course Contents

Introduction: Introduction to Artificial Intelligence-Search-Heuristic Search-A* algorithm-Game Playing- Alpha-Beta Pruning-Expert Systems-Inference-Rules-Forward Chaining and Backward Chaining- Genetic Algorithms.

Knowledge Representation and Reasoning: Proposition Logic - First Order Predicate Logic – Unification – Forward Chaining -Backward Chaining -Resolution – Knowledge Representation - Ontological Engineering - Categories and Objects – Events- Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information - Prolog Programming.

Uncertainty: Non-monotonic reasoning-Fuzzy Logic-Fuzzy rules-fuzzy inference-Temporal Logic-Temporal Reasoning-Neural Networks-Neuro-fuzzy Inference

Learning: Probability basics - Bayes Rule and its Applications - Bayesian Networks – Exact and Approximate. Inference in Bayesian Networks - Hidden Markov Models - Forms of Learning - Supervised Learning -Learning Decision Trees – Regression and Classification with Linear Models - Artificial Neural Networks – Nonparametric Models - Support Vector Machines - Statistical Learning - Learning with Complete Data - Learning with Hidden Variables- The EM Algorithm – Reinforcement Learning

Intelligence and Applications: Natural language processing-Morphological Analysis-Syntax Analysis-Semantic Analysis- All applications – Language Models - Information Retrieval – Information Extraction – Machine Translation – Machine Learning - Symbol-Based – Machine Learning: Connectionist – Machine Learning

Reference Books:

1. Computational Intelligence: Principles, Techniques and Applications by Amit Konar
2. Computational Intelligence in Business Analytics: Concepts, Methods, and Tools for Big Data Applications" by Sztandera.
3. Computational Intelligence: An Introduction by Andries P Engelbrecht

CSE 5204: Computational Intelligence Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5203.

CSE 5205: Mobile and Wireless Communication
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To know the evolution of Mobile communication and cell concept to improve capacity of the system.
- To know the fading mechanism and types of fading and effect of fading on Mobile communication.
- To know the role of equalization in Mobile communication and to study different types of Equalizers and Diversity techniques.
- To know the types of channel coding techniques, data transmission modes and services of GSM.
- To know the types of channel coding techniques, data transmission modes and services of CDMA.

Course Contents

Introduction to radio wave propagation. Large scale fading: (reflection and scattering), small scale fading and multipath propagation. Path loss models, diversity and combining schemes, different pdf of path loss, evolution of 3G mobile cellular communication, cell planning and traffic analysis, QPSK and OQPSK modulation, long code generator, pilot channel, synch channel, paging channel, access channel and traffic channel, rake, receiver, satellite based mobile cellular communication, mobile IP, WCDMA, UMT-2000, IMT 2000, CDMA-2000, MIMO and STBC, OFDM and concept of wireless sensor network.

Reference Books:

1. Wireless Communications Principles and Practice, Theodore S. Rappaport, LPE-2002
2. Mobile and Persinal Communication Systems and Services, Rajpandya, LPE-2004
3. Modern wireless Communications, Simon Haykin and Michael Moher, Lpe-2008
4. CDMA Mobile Communication, Man Young Rhee, 1998
5. Principles of Wireless Networking, K. Pahlavan and P. Krishnamurthy, LPE-2005

CSE 5206: Mobile and Wireless Communication Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5205.

CSE 5207: Data Mining
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- It is an introduction to the field of data mining (also known as knowledge discovery from data, or KDD for short).
- It focuses on fundamental data mining concepts and techniques for discovering interesting patterns from data in various applications.
- It emphasizes techniques for developing effective, efficient, and scalable data mining tools.

Course Contents

Introduction: Models, methodologies, and processes. The KDD process. Generic tasks, Application, Example: weather data

Warehouse and OLAP: Data Warehouse and DBMS, Multidimensional data model, OLAP operations, Example: loan data set

Data preprocessing: Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Experiments with Weka - filters, discretization

Data mining knowledge representation: Task relevant data, Background knowledge, Interestingness measures, Representing input data and output knowledge, Visualization techniques, Experiments with Weka - visualization

Attribute-Value Learning Techniques: Attribute generalization, Attribute relevance, Decision trees. Decision lists. Classification and regression trees. Association rules. Correlations. Rule-based mining. The prediction task, Statistical (Bayesian) classification, Instance-based methods (nearest neighbor), Linear models, Experiments with Weka - using filters and statistics, - mining association rules, decision trees, prediction.

Evaluating what's been learned: Training and testing, Estimating classifier accuracy (holdout, cross-validation, leave-one-out), Combining multiple models (bagging, boosting, stacking), Experiments with Weka - training and testing.

Clustering: Basic issues in clustering, First conceptual clustering system: Cluster/2, partitioning methods: k-means, expectation maximization (EM), Hierarchical methods: distance-based agglomerative and divisible clustering, Conceptual clustering: Cobweb, Experiments with Weka - k-means, EM, Cobweb.

<u>References</u>:

1. J. Han and M. Kamber : **Concepts and Techniques**, *Morgan Kaufmann Publishers*.
2. Ian H. Witten and Eibe Frank, Data Mining : **Practical Machine Learning Tools and Techniques**, *Morgan Kaufmann*
3. Tan, Steinbach, Kumar : **Introduction to Data Mining**, *Addison-Wesley*
4. David L. Olson and Dursun Delen : **Advanced Data Mining and Techniques**, *Springer*
5. Maimon, O. and Last, M. : **Knowledge Discovery and Data Mining - The Info-Fuzzy Network (IFN) Methodology**, *Kluwer Academic Publishers, Massive Computing Series*.
6. Mitchell, T.M. : **Machine Learning**, *McGraw-Hill*.

CSE 5208: Data mining Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5207.

CSE 5209: Semantic Web Technologies
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- Understand the basic concepts and principles of different theoretical models of the semantic web technologies and assess their applicability to some specific domains.
- Understand the concepts of metadata, semantics of knowledge and resource, graph-based RDF models, RDF Schema, ontologies, and their descriptions in XML-based syntax and web ontology language (OWL).
- Be able to describe, build, analyze, edit and query Ontologies.
- Use ontology engineering approaches in semantic applications.
- Be able to design and program domain specific semantic applications.

Course Contents

Introduction to Semantic Web: Overview of semantic web with special emphasis on ontologies and resource annotation (documents, texts, web pages, web services, DBs, etc). DIKW pyramid, knowledge modeling concepts such as propositional logic, first order logic, description logics, metadata, ontologies, rules, important web standards for representing data and knowledge including XML, XML document model, XML validate using DTDs and XML schema, knowledge representation. Current best practices and standards for publishing data on the web, Industry-based approaches and applications in Google, Microsoft, IBM and Facebook. Description of various types of problems, this technology can be applied to.
Ontologies*:* Theoretical aspects: definition, scope, types of ontologies, ontology repositories. Languages used in ontology: Resource Description Framework (RDF), Resource Description Framework Schema (RDFS) and Web Ontology Language (OWL) as well as query languages: SPARQL. Ontology development with Sesame, Jena, Protégé toolkit as well as ontology reasoning tools. Life cycles and development methodologies used in building ontologies from scratch. Ontology networks used in building ontologies through collaborative work. Ontology engineering in ontology alignments and mappings.
Linked Data and search Techniques: Linked Data (LD), Linked Open Data (LOD), advantages of LD instead of traditional API, LD principles, 5-star system of LOD, vocabularies and applications, Algorithm for search techniques– keyword-based search, natural language search, text searching, semantic search, semantic metadata, indexing – feature based indexing and searching, searching in multidimensional space, spidering/crawling, link analysis - HITS, Page Rank, inference rules, recall and precision.
Computational Linguistics: Computational linguistics concepts useful in building ontologies,

concepts, terms, relations, definitions, etc. Types of terminological resources: lexicons, thesauri, mono-, multilingual dictionaries, controlled-language vocabularies, terminological DBs. Text similarity, text indexing, preprocessing and file organization, ConceptNet. Multilingual representation using ontologies.

Semantic Web in Depth: Semantic web and web 2.0. Methods, techniques and tools used in (semi)-automatic annotation of texts and multimedia documentation. Procedures and methods to transform information into semantic web enable contents. Architectures and languages used in creating semantic web services (WSMO, OWL-S). RIF, SWRL, Rule-based multi-agent systems, Trustworthy systems and community, privacy and platform for privacy preferences, Data provenance and integrity management, Applications using semantic web technologies in the data integration, secure semantic interoperability, data exchange, decision making, learning, health, e-business, knowledge management, semantic portals, digital libraries and so on.

Books Recommended

1. Foundations of Semantic Web Technologies, Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph
2. Semantic Web Technologies: Trends and Research in Ontology Based Systems John Davies, Rudi Studer, Paul Warren (Wiley Publications)
3. Semantic Web And Ontology : Dhana Nandini

CSE 5210: Semantic Web Technologies Lab

Credits: 1

Contact: 2 Hours/Week

This laboratory course is based on CSE 5209.

CSE 5211: Cloud Computing

Credits: 3

Contact: 3 Hours/Week

Course Objectives

- To provide students with the fundamentals and essentials of Cloud Computing.
- To provide students a sound foundation of the Cloud computing so that they are able to start using and adopting Cloud Computing services and tools in their real life scenarios.
- To enable students exploring some important cloud computing driven commercial systems and applications.
- To expose the students to frontier areas of Cloud Computing and information systems, while providing sufficient foundations to enable further study and research.

Course Contents

Introduction to different types of computing: Edge computing, Grid computing, Distributed Computing, Cluster computing, Utility computing, Cloud computing.

Cloud computing architecture: Architectural framework; Cloud deployment models; Virtualization in cloud computing; Parallelization in cloud computing; Green cloud. Cloud Bus;

Cloud service models: Software as a Service (SaaS); Infrastructure as a Service (IaaS); Platform as a

Service (PaaS).
Foundational elements of cloud computing: Virtualization; Cloud computing operating System; Browser as a platform; Advanced web technologies (Web 2.0, AJAX and Mashup); Introduction to autonomic systems; Service Level Agreements (SLA); Security/Privacy; Cloud economics; Risks assessment; Current challenges facing cloud computing. **Case studies.**
Practical sessions: Creating Windows servers on the cloud; Creating Linux servers on the cloud; Deploying applications on the cloud; Major cloud solutions.

References:

1.	J. Lin and C. Dyer, Morgan and Claypool	:	**Data-Intensive Text Processing with Map Reduce,** *2010.*
2.	T. Velte, A. Velte, R. Elsenpeter	:	**Cloud Computing, A Practical Approach,** *McGraw-Hill.*
3.	John W. Rittinghouse and James F. Ransome	:	**Cloud Computing, Implementation, Management, and Security,** *CRC Press.*
4.	George Reese	:	Cloud Application Architectures, *O'Reilly.*
5	Andrew S. Tanenbaum, and Maarten van Steen	:	**Distributed Systems: Principles and Paradigms,** *Prentice Hall.*
6.	Abraham Silberschatz, Peter B. Galvin, and Greg Gagne		**Operating System Concepts,** *Wiley.*

CSE 5212: Cloud Computing Lab.
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5211.

CSE 5213: Graph Theory and Computational Geometry
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To understand and apply the fundamental concepts in graph theory.
- To apply graph theory based tools in solving practical problems.
- To improve the proof writing skills.

Course Contents

Fundamental Concepts, varieties of graphs, path, cycles and components, degrees and distances, clique Trees : Properties, spanning trees, forests, centroids, generation of trees and cycles, independent cycles and co-cycles Connectivity : Vertex and edge connectivity, blocks, eccentricity, Menges theorem Traversability: Eulerian graphs, Hamiltonian graphs, Kuratowski theorem, embedding graphs on surfaces, genus, thickness and crossing number coloring : Vertex coloring, edge coloring, Chromatic number, five color theorem, four color conjecture, critical graph, Homomorphism Digraph : Different Connectedness, Oriented graphs tournament, network flows and related algorithms Groups, polynomials and graph enumeration, matching and factorization, perfect graphs, Ramsey number and Ramsey theorem forbidden graph theory, miscellaneous applications.

Recommended Books:

1. Harary, Graph Theory 2001, India, Narosa, India
2. Bondy,J. A. and Murty,U.S.R., 'Graph Theory with Applications', Springer, 2008.

CSE 5214: Graph Theory Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5213.

CSE 5215: Block Chain Technology
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- To provide conceptual understanding of how blockchain technology can be used to innovate and improve business processes.
- To cover the technological underpinning of blockchain operations in both theoretical and practical implementation of solutions using blockchain technology.

Course Contents

Introduction: Need for Distributed Record Keeping, Modeling faults and adversaries, Byzantine Generals problem, Consensus algorithms and their scalability problems, Technologies Borrowed in Blockchain –hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash;
Basic Distributed Computing: Atomic Broadcast, Consensus, Byzantine Models of fault tolerance;
Basic Crypto primitives: Hash functions, Puzzle friendly Hash, Collison resistant hash, digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems;
Blockchain 1.0: Bitcoin blockchain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their use;
Blockchain 2.0: Ethereum and Smart Contracts, The Turing Completeness of Smart
Contract Languages and verification challenges, Using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts;
Blockchain 3.0: Hyperledger fabric, the plug and play platform and mechanisms in permissioned blockchain; Privacy.
Security issues in Blockchain: Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains – such as Sybil attacks, selfish mining,51% attacks - advent of algorand, and Sharding based consensus algorithms to prevent these.

Reference Books

1. Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond by Chris Burniske and Jack Tatar.
2. Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World by Don and Alex Tapscott.
3. The Book Of Satoshi: The Collected Writings of Bitcoin Creator Satoshi Nakamoto by Phil Champagne.

CSE 5216: Block Chain Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5215.

CSE 5217: Mobile Application and Game Development
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- This course is concerned with the development of applications on mobile and wireless computing platforms. Android will be used as a basis for teaching programming techniques and design patterns related to the development of standalone applications and mobile portals to enterprise and m-commerce systems.
- Emphasizes is placed on the processes, tools and frameworks required to develop applications for current and emerging mobile computing devices.
- Students will work at all stages of the software development life-cycle from inception through to implementation and testing.
- In doing so, students will be required to consider the impact of user characteristics, device capabilities, networking infrastructure and deployment environment, in order to develop software capable of meeting the requirements of stakeholders.

Course Contents

Introduction: Introduction to Mobile Computing- Introduction to Android Development Environment. Factors in Developing Mobile Applications- Mobile Software Engineering, Frameworks and Tools, Generic UI Development, Android.
App Development: Framework, Architecture, Design, Technology Selection, Development Process, Development Tools. Intents on UIs, VUIs- Designing the Right UI, Multichannel and Multimodal UIs. Intents and Services- Android Intents and Services, Characteristics of Mobile Application, Successful Mobile Development. Storing and Retrieving Data Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider, Text-to-Speech Techniques, Mobile App Development Hurdles etc.
Communications over Network and Web: Communications Via Network and the Web- State Machine, Correct Communications Model, Android Networking and Web. Telephony- Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony. Notifications and Alarms– Performance, Performance and Memory Management, Android Notifications and Alarms etc.
Graphics and Threading: Graphics- Performance and Multithreading, Graphics and UI Performance, Android Graphics. Multimedia Mobile Agents and Peer-to-Peer Architecture, Android Multimedia. Location- Mobility and Location Based Services, maps.
Packaging, Testing & Deployment: Packaging and Deploying, APK files, Testing– alpha, beta, Use of simulator, testing on real devices, Deploying in Marketplace, Performance Best Practices, Android Field Service App
Security and Hacking : Security- Active Transactions, Rooting, more on Security aspects like Secure profile– work profile, user profile. Hacking Android.

Reference Book:

1. Head First Android Development-A Brain-Friendly Guide By Dawn Griffiths, David Griffiths ,

2015 , O'Reilly Media
2. Learn Android Studio 3 with Kotlin- Efficient Android App Development , By Ted Hagos , 2018, Apress
3. Android App Development , By Franceschi , 2016 , Jones & Bartlett Learning
4. Professional Mobile Application Development, 11 October 2012 by Jeff Mcherter and Scott Gowell

CSE 5218: Mobile Application and Game Development Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5217.

CSE 5219: Software Maintenance and Evolution
Credits: 3
Contact: 3 Hours/Week

Course Objectives

- Have a solid understanding of fundamental concepts of software maintenance & evolution
- Understand some of the state-of-the-art techniques used in maintaining and evolving legacy systems
- Learn the processes involved in software evolution
- Learn legacy system management
- Understand how legacy systems can be assessed to decide whether they should be scrapped, maintained, reengineered, or replaced
- Learn reverse engineering and reengineering for program comprehension techniques • Understand software reuse

Course Contents

Overview of software maintenance, Different types of software maintenance, Software maintenance metrics and case studies, Maintenance prediction (number of changes, cost, impact analysis), Evolution process models, Legacy system reengineering and reuse, Reverse engineering and program understanding, Software and Information Visualization, Software system re-documentation, Service Oriented Architecture (SOA), Agile software development, Requirements Engineering

Reference Book

1. HeadFirst Android Development-A Brain-Friendly Guide By Dawn Griffiths, David Griffiths , 2015 , O'Reilly Media
2. Learn Android Studio 3 with Kotlin- Efficient Android App Development , By Ted Hagos , 2018, Apress
3. Android App Development , By Franceschi , 2016 , Jones & Bartlett Learning
4. Professional Mobile Application Development, 11 October 2012 by Jeff Mcherter and Scott Gowell

CSE 5220: Software Maintenance and Evolution Lab
Credits: 1
Contact: 2 Hours/Week

This laboratory course is based on CSE 5219.