Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Structure & Syllabus of

B.Tech.

(Artificial Intelligence and Data Science)

Pattern'B20'

Effective from AcademicYear 2021-22

Prepared by: - Board of Studies in Information Technology

Approved by: -AcademicBoard, VishwakarmaInstituteofTechnology,Pune

Signedby

Chairman– BOS   **Chairman–AcademicBoard**

B.Tech.Artificial Intelligence and Data Science(applicable w.e.f. AY2021-22)

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B.Tech.ArtificialIntelligenceandDataScienceStructure

(Applicable w.e.f.AY21-22)
SYAI&DSModule-III (B21Pattern)

Subject head	Course code	Coursename	Contact hours perweek			Credits
			Theory	Lab	Tut	
S1	**MD2201**	**Data Science**	**3**	**1**	**2**	**5**
S2	**CS2221**	**Internet of Things**	**3**	**1**	**2**	**5**
S3	**CS2218**	**Object OrientedProgramming**	**3**	**1**	**2**	**5**
S4	**IT2201**	**ComputerOrganization and Architecture**	**3**	**1**	**2**	**5**
S5	**AI2004**	**SoftwareDevelopmentProject – I**	**-**	**-**	**-**	**3**
S6	**AI2005**	**EngineeringDesign andInnovation -I**	**-**	**-**	**-**	**4**
		Total				**27**

SYAI&DSModule-IV (B21Pattern)

Subjecthead	Coursecode	Coursename	Contact hours perweek			Credits
			Theory	Lab	Tut	
S1	**AI2001**	**Advanced DataStructures**	**3**	**2**	**1**	**5**
S2	**AI2002**	**Discrete Structureand Automata Theory**	**3**	**2**	**1**	**5**
S3	**AI2003**	**Computer Network**	**3**	**2**	**1**	**5**
S4	**AI2006**	**Database Management and Data Mining (HONOUR COURSE)**	**3**	**2**	**1**	**5**

S6	AI2004	Software Development Project –II	-	-	-	3
S5	AI2005	Engineering Design and Innovation – II	-	-	-	4
		Total	**12**	**08**	**4**	**27**

FF No.: 654

COURSE CODE: MD2201   **COURSE NAME: DATA SCIENCE**

Course Prerequisites:
1. Linear Algebra Basics
2. Central Tendency & Measures of Dispersion – Mean, Mode, Median
3. Probability
4. Some exposure to programming environment – C programming; Python

Course Objectives:
1. Understand data processing pipeline
2. Perform dimensionality reduction operations
3. Optimize the performance of functions
4. Apply descriptive statistics tools
5. Deduce meaningful statistical inferences
6. Use unsupervised classification algorithms
7. Use supervised classification algorithms
8. Utilize the data science principles for an entire project life cycle as a case study

Credits: 5   **Teaching Scheme Theory: 3** Hours/Week
                                              Tut: 1 Hours/Week
                                              Lab: **2** Hours/Week

Course Relevance:
The course is offered in S.Y. B.Tech. to all branches of Engineering
Data Science is a multidisciplinary field. It uses scientific approaches, procedures, algorithms and frameworks to extract knowledge and insight from a huge amount of data.
Data Science uses concepts and methods which belong to fields like information technology, Mathematics, Statistics, Computer Science etc.
Data Science influences the growth and improvements of the product by providing a lot of intelligence about customers and operations, by using methods such as data mining and data analysis.
The course is relevant to all branches of Engineering and beyond, since data is generated as an obvious outcome of many processes.

SECTION-1

- Introduction to Data Science

  Role of data scientist, introduction to R, R studio; introduction to univariate and multivariate systems, understanding databases, Data Processing - Data collection; Data preparation; Data visualization techniques and inferences - scatter plot, scatter matrix, histogram, box plot. **(6 Hours)**
- Normal distribution, evaluating normal distribution, Binomial distribution, confidence Intervals, central limit Theorem, hypothesis testing, inference for numerical data – t-distribution, paired data, ANOVA **(8 Hours)**
- Vector norms, distances & projections, discriminants, Principal Component Analysis, Optimization: constrained and unconstrained, Gradient Descent **(6   Hours)**

SECTION-2

- Supervised Learning – line fitting, residuals, correlation; line fitting by least squares regression; outliers in linear regression; Inference for linear regression; Multiple regression; Model selection; Logistic regression, Nearest Neighbor Classification – Knn; Naïve Bayes Classification – Bayesian methods, Bayes algorithm; Classification using decision trees and learners **(9 Hours)**
- Unsupervised Clustering - K-means clustering; Evaluation of model performance – Confusion matrices, sensitivity, specificity, kappa statistics, precision, recall, F-measure, ROC curve etc.; Methods of cross-validation, Bootstrapping; Meta-learning through ensemble approach – Bagging, boosting, Random Forests strategies. **(7 Hours)**
- Classifier performance measurement metrics – Training & Testing strategies – Resubstitution, Hold-out, Cross validation, Bootstrap ; Confusion matrix, Performance measures – Accuracy, Error rate, Sensitivity, Specificity, Precision, Recall, F-Measure, Receiver Operating Characteristics curves **(4 Hours)**

List of Tutorials:

1. Data Visualization
2. Distances and Projections
3. Singular Value Decomposition
4. Principal Component Analysis
5. Optimization
6. Normal & Binomial Distribution
7. Hypothesis Testing
8. ANOVA test
9. Linear Regression
10. Logistic Regression
11. Nearest Neighbor Classification
12. Decision Trees based classification
13. Naive Bayes classification

14. Clustering
15. Evaluation of model performance
16. Bagging & Boosting approaches

List of Practicals: (Any Six)

1. Data visualization
2. Unconstrained Optimization
3. Hypothesis Testing
4. Linear regression
5. Logistic Regression
6. Nearest Neighbor classification
7. Naive Bayes classification
8. Clustering
9. Classifier performance using Confusion matrix and other attributes
10. Cross Validation methods

List of Course Projects:

1. Movie recommendation system
2. Customer Segmentation using Machine Learning
3. Sentiment analysis
4. Uber Data analysis
5. Loan prediction
6. HVAC needs forecasting
7. Customer relationship management
8. Clinical decision support systems
9. Development of machine learning solutions using available data sets (multiple projects)
10. Fraud detection

List of Course Seminar Topics:

1. Data wrangling
2. Predictive modeling
3. Data analytics in life science (multiple topics)
4. Ensemble modeling techniques
5. Text pre-processing
6. Feature scaling for machine learning
7. Multivariate normal distribution applications
8. Distance metrics and their applications
9. Visualization techniques such as Chernoff's faces
10. Tree based algorithms
11. Ridge regression
12. LASSO

List of Course Group Discussion Topics:

1. PCA and ICA
2. Hierarchical and nonhierarchical systems
3. Linear - Non linear regression
4. Parametric-non parametric estimation
5. Overfitting and underfitting in the context of classification
6. Linear and Quadratic discriminant analysis
7. Regression v/s classification
8. Classifier performance measures
9. Supervised and unsupervised learning
10. Various clustering approaches
11. Classifiers and classifier combinations
12. Balancing errors in hypothesis testing
13. Standard sampling practices for a successful survey for reliable sample data

List of Home Assignments:

Case Study: A very large number of resources are available for data generated out of case study. Unique Home assignments will be set up for all groups
Surveys: Principles of surveying will be implemented by groups to demonstrate use of data science principles in home assignments

Assessment Scheme:

Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks

Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

Text Books: *(As per IEEE format)*

1. *'A Beginner's Guide to R' – Zuur, Leno, Meesters; Springer, 2009*
2. *'Introduction to Data Science' – Igual, Segui; Springer, 2017*
3. *'Mathematics for Machine Learning' – Diesenroth, Faisal, Ong; Cambridge University Press, 2017*
4. *'Machine Learning with R' – Lantz, Packt Publishing, 2018*

Reference Books: *(As per IEEE format)*

1. *'Elements of Statistical Learning' - Hastie, Tibshirani, Friedman; Springer; 2011*
2. *'Data Science from Scratch' - Grus; Google Books; 2015*
3. *'The art of Data Science' - Matsui, Peng; 2016*
4. *'Machine Learning for absolute beginners' - Theobald; Google Books; 2017*

Moocs Links and additional reading material:www.nptelvideos.in
1. https://www.edx.org/course/machine-learning-fundamentals-2
2. https://www.edx.org/course/foundations-of-data-analysis-part-1-statistics-usi
3. https://www.coursera.org/learn/statistical-inference/home/welcome
4. https://www.coursera.org/learn/data-scientists-tools/home/welcome

Course Outcomes:

Upon completion of the course, student will be able to –
1. Apply Data processing & data visualization techniques - 3
2. Implement dimensionality reduction & optimization techniques for enhancing data suitability - 5
3. Perform Descriptive and Inferential statistical analysis for building reliable predictions - 4
4. Implement Supervised algorithms for classification and prediction - 4
5. Implement Unsupervised classification algorithms - 3
6. Evaluate the performance metrics of supervised and unsupervised algorithms - 2
7. Demonstrate complete Data Science life cycle with case studies - 4

Future Courses Mapping:

1. Deep Learning
2. Reinforcement Learning
3. DBMS
4. Big Data
5. Data Mining
6. Information Retrieval
7. Recommendation Systems
8. Cloud Computing – AWS
9. IOT
10. Artificial Intelligence
11. Pattern Recognition
12. Natural Language Processing
13. Computer Vision
14. Machine Vision
15. Fault Diagnosis
16. Optimization
17. Bioinformatics
18. Computational Biology
19. Econometrics
20. Supply Chain
21. Ergonomics
22. Operations Research
23. Nano-informatics

Job Mapping:

Job opportunities that one can get after learning this course
1. Data Scientist
2. Data Analyst
3. AI Engineer
4. Data Architect.
5. Data Engineer.
6. Statistician.
7. Database Administrator.
8. Business Analyst
9. Business Intelligence Developer
10. Infrastructure Architect
11. Enterprise Architect
12. Machine Learning Engineering
13. Machine Learning Scientist

FF No. : 654

COURSE CODE: CS2221   **COURSE NAME: INTERNET OF THINGS**

CoursePrerequisites:
StudentsshouldhaveabasicUnderstanding of the Internet, Cloud, Networking Concepts and Sensors

CourseObjectives:
The student will be able to
1. UnderstandIoTArchitectureand framework.
2. Recognize and differentiate between the various use cases of different sensors, actuators, solenoid valve etc
3. Learnaboutfundamentalconceptsofnetworkingandprotocols.
4. UnderstandIoTPhysical, Datalink and Higher layer Protocols.
5. Applytheoretical knowledgeforCloud computing.
6. Implement an IoT solution practically.

Credits: 5   **Teaching Scheme**   **Theory: 3** Hours/Week
                                                          Tut: 1 Hours/Week
                                                          Lab: **2** Hours/Week

Course Relevance:
The Internet of Things is transforming our physical world into a complex and dynamic system of connected   devices   on   an   unprecedented   scale. InternetofThingsisasystemofinterrelatedcomputingandsensingdevicesandhastheabilitytotransferdata overanetworkwithoutrequiringhuman-to-humanorhuman-to-computerinteraction.
Advances in technology are making possible a more widespread adoption of IoT, from pill-shaped micro-cameras that can pinpoint thousands of images within the body, to smart sensors that can assess crop conditions on a farm, to the smart home devices that are becoming increasingly popular. IoTishighlyrelevantinthisgrowingecosystemofinternet-enableddevices.IoToffersincreasing
opportunities to collect, exchange, analyse and interpret data in real-time. This robustaccessto data willresultin opportunitiesto furtherenhanceand improveoperations. In a world which is moving towards an increasingly connected future, Internet of Things (IoT) is the next big thing. Right from our homes to our cars to our cities, everything is being connected and the technology of IoT is right in the middle of it.

SECTION-1
Introduction to IoT

Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels & Deployment Templates, IoT and M2M**(6 Hours)**

IOT Platform Design Methodology

IoT Design Methodology Steps, Home Automation Case Study, Smart Cities, Health Care, Agriculture, Manufacturing and Logistics **(7 Hours)**

IoT Devices

IoT System Design Cycle, Sensors - Terminologies, Calibration, Types, Specification, Use, Actuators - Types and Use, Prototype Development Platform - Arduino / Raspberry pi / Node MCU, Interface with Embedded System**(7 Hours)**

SECTION-1I

Introduction to Wireless Sensor Network

Sensor Node, Smart Sensor Network, Wireless Sensor Network, RFID - Principles and Components, Node MCU**(5 Hours)**

Connectivity Technologies

Network Configuration in IoT, IoT Stack and Web Stack, IEEE 802.15.4 Standard, Zigbee, Bluetooth, Overview of IoT Protocols, MQTT, Cloud Architecture and Types,
Cloud Service Providers**(10 Hours)**

Case Studies (Any Three from following List to be covered☺

Smart lighting, Home Intrusion Detection, Smart Parking, Weather Monitoring System, Weather Report Bot, Air Pollution Monitoring, Forest fire Detection, Smart Irrigation, IoT Printer, IoT in Manufacturing Industry, IoT in Process Industry, IoT in Quality, Control Applications in Industry, IoT in Material Handling System in Industry, IoT in Automobile Industry, Navigation System, Connected Vehicles, Industry 4.0**(5 Hours)**

ListofPracticals: (MinimumSix)

1. Setting up Arduino / Raspberry Pi/ Node MCU ESP8266 : Basic handling , programming
2. LED Interfacing
3. Sensor interface to Node MCU/Arduino / Raspberry Pi Temperature measurement using LM35
4. Actuator interface to Node MCU /Arduino / Raspberry Pi Traffic Signal Control
5. Node MCU /Arduino / Raspberry Pi wireless communication Raspberry Pi as a web server
6. Node MCU/Arduino / Raspberry Pi Cloud interfacing and programming like Thingspeak Email alert using SMTP protocol
7. Sensor data acquisition on Mobile (Mobile APP) / Developing Application (WEB APP) with Django Text transfer using MQTT protocol
8. Home Automation using Cisco Packet Tracer

ListofCourse Projects:

1. Smart Agriculture System
2. Weather Reporting System
3. Home Automation System
4. Face Recognition Bot
5. Smart Garage Door
6. Smart Alarm Clock
7. Air Pollution Monitoring System
8. Smart Parking System
9. Smart Traffic Management System
10. Smart Cradle System
11. Smart Gas Leakage Detector Bot
12. Streetlight Monitoring System
13. Smart Anti-Theft System
14. Liquid Level Monitoring System
15. Night Patrol Robot
16. Health Monitoring System
17. Smart Irrigation System
18. Flood Detection System
19. Mining Worker Safety Helmet
20. Smart Energy Grid

List ofCourseSeminarTopics:

1. IoTArchitecture
2. SensorCharacteristics
3. IoTforsupplychainmanagementandinventorysystems
4. IoTEthics
5. SecurityinIoT
6. CloudComputingPlatform
7. IoTBestPractices
8. 5GinIoT
9. MiddlewareTechnology
10. M2Menergyefficiencyroutingprotocol
11. IoTbasedBiometricImplementation
12. CompleteIoT solutionusingAWS
13. A smart patient health monitoring system
14. IoT for intelligent traffic monitoring
15. Home automation of lights and fan using IoT

ListofGroupDiscussionTopics:

1. Role of Internet of Things in development of India .
2. Manufacturing industries should make efforts to limit contribution to IoT.
3. Should countries put a ban on IoT for children?
4. Should IoT pay more attention to security rather than just expanding its horizon to the extremes?
5. IoT is the next big thing in technology.
6. IoT poses a huge risk to privacy, if they your system is hacked.
7. IoT is the next big thing for hackers trying to have access to your intimate data.
8. Pros and cons of over-usage of IoT at homes and offices.
9. IoT at battlefields will make life of soldiers safer and easier.
10. IoT will make way for robots to rule over humans one day.
11. IoT devices are making people lazier and obese.
12. IoT needs to be regulated before it goes out of limits and poses serious threat.

List of Home Assignments:

Design:
1. SmartCity
2. SmartTransportation
3. SmartHealthcare
4. SmartIndustryusingIoT
5. DesignofIoTframework

CaseStudy:
1. OpenSourcein IoT
2. IoTsolutionsfor automobile
3. Cloud Computing
4. AWS
5. MicrosoftAzure

Blog:
1. NetworkSelectionforIoT
2. Needofsecureprotocols
3. Futureof IoT
4. IIoT
5. IoTand Industry4.0

Surveys:
1. AutonomousVehicles
2. ListofIndiancompanieswhichofferIoTsolutionsforagricultureandfarming.Describethepro blem they areaddressing andtheir solution.
3. Make a list of Indian companies which offer IoT solutions for healthcare. Describe theproblemthey areaddressing and theirsolution.
4. Makeanexhaustivelistofeverythinginside,justoutside(immediatesurroundings)andon the auto body which must be "observed" for safe and comfortable driving usingautonomousvehicles.
5. ComparedifferentCloudServiceprovidersinthe market.

TextBooks:*(Asper IEEE format)*

1. *Arshdeep Bahga and VijayMadisetti,"InternetofThings:AHands-on Approach",(UniversitiesPress)*
2. *PethuruRajandAnupamaC.Raman,"TheInternetofThings:EnablingTechnologies,Platforms,and UseCases", (CRC Press)*

ReferenceBooks:

1. *Adrian McEwen, Hakim Cassimally "Designing the Internet of Things", Wiley*
2. *OvidiuVermesan&PeterFriess"InternetofThingsApplications-FromResearchandInnovationtoMarket Deployment", ISBN:987-87-93102-94-1,RiverPublishers*
3. *JoeBironandJonathanFollett,"FoundationalElementsofanIoT Solution,"byJoeBiron*

MOOCs Links and additional reading material:

1. https://proed.stanford.edu/course/view.php?id=191
2. https://nptel.ac.in/courses/106/105/106105166/
3. https://create.arduino.cc/projecthub/electropeak/getting-started-w-nodemcu-esp8266-on-arduino-ide-28184f

Course Outcomes

1. DemonstratefundamentalconceptsofInternetofThings(CO Attainmentlevel:2)
2. Recognize IoT Design Methodology Steps(COAttainmentlevel:3)
3. Selectsensorsfordifferent IoTapplications (COAttainmentlevel:3)
4. Analyzefundamentalsofnetworking (COAttainmentlevel:4)
5. Apply basic ProtocolsinIoT(CO Attainmentlevel:4)
6. Provide IoT solutions practically with the help of case study(COAttainmentlevel:5)

FutureCoursesMapping:

Othercourses thatcan betakenafter completionof this course
1. Ad-HocNetworks
2. Cyber Security
3. Wireless Networks
4. Industry 4.0
5. Big Data

JobMapping:

The Internet of Things (IoT) is the most emerging field in today's world. It is revolutionizingevery industry, from home appliances to agriculture to space exploration. Since the advent ofcloud computing, there hasbeen an exponential growth in the number of sensor-enableddevices connected to the internet and expecting further growth accelerating in the comingyears. There are diversified career opportunities in this field. The various career positionsavailableasIoTResearchDeveloper,IoTDesignEngineer,IoTProductManager,IoTSoftwareDeveloper, IoTSolutionArchitect, IoTServiceManager andmany more.

Assessment Scheme:
Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
 Comprehensive Viva Voce - 20 Marks

COURSE CODE: CS2218   COURSE NAME: OBJECT ORIENTED PROGRAMMING

Course Prerequisites:
Basic course on programming

Course Objectives:
1. Understand Object Oriented programming concepts
2. Demonstrate Object Oriented programming concepts by writing suitable Java programs
3. Model a given computational problem in Object Oriented fashion
4. To develop problem solving ability using Object Oriented programming constructs like multithreading
5. Develop effective solutions using for real world problems using the concepts such as file handling and GUI
6. Implement applications using Java I/O and event-based GUI handling principles

Credits: 5   **Teaching Scheme Theory: 3 Hours/Week**
                                        Tut: 1 Hours/Week
                                        Lab: 2 Hours/Week

Course Relevance:
This is an important course for engineering students. It develops computational problem solving and logic building capability of students. Acquiring programming skills has a high relevance in all branches of Engineering. Once the student gains expertise in coding, this course proves to be beneficial to them to excel in industry demanding coding in specific software.

SECTION-1

Introduction:
What is Object Oriented Programming (OOP)? The need of OOP, Characteristics of OOP.

Java overview: Classes and Objects, Java object storage, Different ways to create objects in Java, Access Modifiers, this reference, main method, Static vs Instance block, Static methods vs Instance methods in Java, Object class, Static class in Java, operators, keywords in java.

Constructors: Constructors in Java, Default constructor, Parameterized constructor, Copy Constructor, Private Constructors and Singleton Classes. **Garbage Collection:** Garbage Collection, How to make object eligible for garbage collection in Java?

Input and Output: Byte Stream vs Character Stream, Command Line arguments, use of Scanner Class, Scanner vs BufferReader Class, Formatted output, Reading input from console.

Arrays in Java: Arrays in Java, initialization, Default Array values, multi dimensional array, passing array to a function, Jagged arrays, java.util.Arrays class, string class, string buffer, string builder.

Methods in Java: Methods, Parameters passing, Returning Multiple values, Throwable fillInStackTrace() method in Java, Valid variants of main(), Variable Arguments (Varargs) method

Inheritance: Inheritance in Java, Types, Constructor in Inheritance, Using final with Inheritance, Accessing superclass member, Override private methods, Parent and Child classes having same data member, Base vs derived class reference. Polymorphism: Method Overloading, Overloading main(), Static vs Dynamic Binding, Method Hiding. Private and final methods, Passing and Returning Objects in Java

SECTION-2

Exception Handling: Exceptions, types, types of handling exception, Checked vs Unchecked Exceptions, Throw and Throws, User-defined Exception, Chained Exceptions.

Interfaces and Abstract Classes: Interface and its usage, Abstract Class and its usage, Difference between Abstract Class and Interface, Nested Interface, Nested Class, Inner class, Anonymous Inner class, Marker interface.

Java Packages: Packages Introduction, default access specifier use, dealing with package.

Collection in Java: Collections Class, Enumeration, Iterators and ListIterator, Using Iterators, Iterator vs Foreach, ArrayList, Vector, Map, Set.

Multithreading: Thread life Cycle, Thread Priority, Thread Methods, Inter-thread Communication, Synchronization, Method and Block Synchronization, Deadlock situation in threading.

File Handling & Database connectivity: File Processing, Primitive Data Processing, Object Data Processing,Wrapper classes, Connecting Java with database (JDBC/ODBC).

Java GUI: AWT, Swing, Components, design patterns. Layout Manager: Flow, Border, Grid and Card. Label, Button, Choice, List, Event Handling (mouse, key), Menus, Tables

List of CourseSeminar Topics:

1. Introduction of Arrays and 1D Array programming examples
2. Multidimensional arrays
3. Variants of main() and command line arguments
4. Input and Output stream classes
5. String concepts and various methods of compairing strings
6. Methods in Java
7. Java String Methods
8. Passing array to a function and Jagged array examples
9. Reading input using Scanner and BufferReader Class
10. String, String buffer and String builder
11. Types of Inheritance in Java
12. Implementation of Types using Constructor in Inheritance
13. Using final with Inheritance
14. Base vs derived class reference in Inheritance
15. Using final with Inheritance, Accessing superclass member
16. Parent and Child classes having same data member
17. Overriding, Hiding Fields & Methods
18. Static vs Dynamic Binding & Hiding Methods
19. Private and final methods
20. Passing and Returning Objects in Java
21. Java Memory Management
22. File handling in Java vs C++
23. Data types used in Java vs C++
24. Java Object Serialization and Deserialization
25. Operator precedence
26. Use of Object Class Methods
27. Garbage collection in JAVA
28. Use of Static Blocks in various applications
29. Keywords used in JAVA
30. Types of Variables In JAVA

List of Group Discussion Topics:

1. Checked and unchecked exception, user defined and standard exception
2. Abstraction in Java and different ways to achieve Abstraction
3. Packages in Java – Types, Advantages & Techniques to Access Packages
4. Inner classes, nested interfaces in Java
5. Difference between Interfaces and abstract classes in Java
6. Exception Handling in Java Vs CPP
7. Difference between 1) throw and throws. 2) Final, finally and finalize in Java

8. Discuss Exception propagation and Discuss Exception handling with method overriding in Java
9. Discuss Packages, Access specifiers and Encapsulation in java.
10. Difference between abstraction and encapsulation in Java.
11. Daemon Threads Vs user threads
12. Preemptive scheduling Vs slicing
13. Is it possible to call the run()method directly to start a new thread? pls comment
14. Arraylist Vs Vector
15. Arrays Vs Collections
16. is Iterator a class or an Interface? what is its use?
17. List Vs Set
18. BufferedWriter and BufferedReader classes in java
19. BufferedReader Vs Scanner class in java
20. Buffered Reader Vs FileReader in java
21. Instanceofjava
22. Difference between CPP and JAVA
23. Difference between JDBC and ODBC connectivity
24. file processing in java
25. Difference between premitive data processing and object data processing
26. Creating GUI using swing
27. comparision between Swing, SWT, AWT, SwingX, JGoodies, JavaFX, Apache Pivot
28. Introduction To JFC And GUI Programming In Java
29. Introduction to wrapper classes
30. Why java uses Unicode System?

List of Practicals:

1. Implement Student class using following Concepts
   - All types of Constructors
   - Static variables and instance variables
   - Static blocks and instance blocks
   - Static methods and instance methods

2. There is a class Adder which has two data members of type 1D int array and int variable. It has two functions: getdata and numsum. Function getdata accepts non-empty array of distinct integers from user in 1D int array data member and a targetsum in another data member. The function numsum adds any two elements from an input array which is equal to targetsum and return an array of resulting two elements, in any order. If no two numbers sum up to the target sum, the function should return an empty array. Note that the target sum is to be obtained by summing two different integers in the array; you can't add a single integer to itself in order to obtain the target

sum. You can assume that there will be at most one pair of numbers summing up to the target sum. Use constructor. Use extra variables if needed

 Input:
Array=[3,5,-4,8,11,1,-1,7]   targetsum=15
Output: [8,7]
Input:
Array=[3,5,-4,8,11,1,-1,6]   targetsum=15
Output: []

3. Write Java program to calculate area of triangle, square & circle using function overloading. Function parameter accept from user (Use function Overloading concepts and Inheritance).

4. Write a program for following exception, develop a suitable scenario in which the following exceptions occur:
     a. divide by zero
     b. Array index out of bounds exception
     c. Null pointer Exception

5. Write a java program to solve producer-consumer problem where there are two producer threads and one consumer thread.

6. Implement various operations using JDBC Connectivity.
7. Display bank account information (Use interface and inheritance using java)
8. Develop a GUI in java which reads, update the file.

List of Course Projects:

Topics of Course Project would be discussed in Lab session.

List of Home Assignments:

 Blog:
     1. Single and Multidimensional arrays in Java
     2. Comparison Inheritance & Polymorphism
     3. Need of abstract classes and interfaces in Java
     4. Multithreading concept in Java
     5. Signed & Unsigned arithmetic operations usin JAVA
     6. Role of start() and run() methods in multithreading

 Survey:
     1. Strategies for Migration from C++ to Java
     2. Product development using Inheritance and Polymorphism in Industry
     3. on Java/OOP features popular amongst developers
     4. Which other (non-JVM) languages does your application use?
     5. How Java Impacted the Internet

6. How can aArrayList be synchronised without using vector?

Design:
1. Implementation of Singleton design pattern in Java
2. Notes Repository System for Academic
3. Design for employee management system
4. Design for student management system
5. Inventory Management System
6. Write a program to delete duplicate numbers from the file

Case Study:
1. Java development milestones from 1.0 to 16.0
2. Implementation of Different Methods in Polymorphism
3. Real world systems which use java for its implementation
4. Drawing a flag using java
5. Use of different methods of Class object
6. Drawing a flag using java

Assessment Scheme:
Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

Text Books:

Herbert Schildt, "JAVA- The Complete Reference", , 11th Edition, McGraw Hill Education

Reference Books:

1. *Bruce Eckel, "Thinking In Java – The Definitive Introduction to Object-Oriented Programming in the Language of the World-Wide Web", Fourth Edition, Pearson Education, Inc.*

2. R. Morelli and R. Walde, "Java, java, Java – Object-Oriented Problem Solving", 3rd edition, Pearson Education, Inc.

Moocs Links and additional reading material:

Programming using Java| Java Tutorial | By Infosys Technology
https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01304972186110361645_shared/overview

An Introduction to Programming through C++ – Prof A.G. Ranade- NPTEL- computer science and engineering – NOC https://nptel.ac.in/courses/106/101/106101208/#

Course Outcomes:

The student will be able to –
1. Understand object-oriented programming features
2. Develop real world applications using class, inheritance and polymorphism
3. Adapt Best Practices of Class Design by using Standard Templates Library
4. Solve computing problems by applying the knowledge of Exception handling and Multithreading
5. Design solutions by choosing suitable data structures such as Array, Vector, Map etc
6. Implement applications using Java I/O and event-based GUI handling principles

Future Courses Mapping:

  Advanced Data Structures, Advanced Java, Spring Frame Work, Grails Frame Work

Job Mapping:

  Java Programmer, Application Developer, Design Engineer, Senior Software Developer

FF No.: 654

COURSE CODE: IT2201

COURSE NAME: COMPUTER ORGANIZATION AND ARCHITECTURE

Course Prerequisites:
Basics of computer system and any programming language.

Course Objectives:
1. To study the fundamental concepts of structural Computersystem and ComputerArithmetic
2. To understand the basic concepts and functions of Microprocessor
3. To gain knowledge of Computer Memory System
4. To get familiar with GPU and CPU architecture
5. To identify solutions for real world design issues using processors.

Credits: 5   **Teaching Scheme Theory: 3** Hours/Week
                                                      Tut: 1 Hours/Week
                                                      Lab: **2** Hours/Week

Course Relevance:

Modern computer technology requires an understanding of both hardware and software, since the interaction between the two offers a framework for mastering the fundamentals of computing.
The purpose of this course is to cultivate an understanding of modern computing technology through an in-depth study of the interface between hardware and software.
 In this course, you will study the history of modern computing technology before learning about modern computer architecture and a number of its essential features, including instruction sets, processor arithmetic and control, the Von Neumann architecture, pipelining, memory management, storage, and other input/output topics.
The course will conclude with a look at the recent switch from sequential processing to parallel processing by looking at the parallel computing models and their programming implications.

SECTION I

Basic concepts of Digital Electronics, Organization and Architecture, Structure & Function, Brief History of computers, Von Neumann Architecture, Integer Representation: Fixed point & Signed numbers. Integer Arithmetic: 2's Complement arithmetic, multiplication, Booth's Algorithm, Division Restoring Algorithm, Non Restoring algorithm, Floating point representation: IEEE Standards for Floating point representations.

8086 Microprocessor Architecture, Register Organization, Instruction types, Types of operands, Instruction formats, addressing modes and address translation. Near & FAR procedure, Instruction cycles. RISC Processors: RISC- Features, CISC Features, Comparison of RISC & CISC Superscalar Processors. Case study of Processor.

Fundamental Concepts: Single Bus CPU organization, Register transfers, Performing an arithmetic/ logic operations, fetching a word from memory, storing a word in memory, Execution of a complete instruction. Micro-operations, Hardwired Control, Example-Multiplier CU. Micro-programmed Control: Microinstructions, Microinstruction-sequencing: Sequencing techniques, Micro-program sequencing

SECTION II

Need, Hierarchical memory system, Characteristics, Size, Access time, Read Cycle time and address space. Main Memory Organization: ROM, RAM, EPROM, E 2 PROM, DRAM, Design examples on DRAM, SDRAM, DDR3, Cache memory Organization: Address mapping. Basic concepts: role of cache memory, Virtual Memory concept. Pipeline and its performance, Data hazards: operand forwarding, handling data hazards in software, side effects. Instruction hazards: unconditional branches, conditional branches and branch prediction.

Parallelism in Uniprocessor system, Evolution of parallel processors, Architectural Classification, Flynn's, Fengs, Handler's Classification, Multiprocessors architecture basics, Parallel Programming Models : Shared memory, Message passing, Performance considerations : Amdahl's law, performance indications.

Parallel computing architectures (multi-core CPUs, GPUs, traditional multi-processor system, Xeon-Phi, Jetson Kit, Kilocore processor), multiprocessor and multicomputer systems, interconnection networks, Modern GPU architecture (in brief), Performance comparison: Speedup, Gain time and scalability.

List of Practical (Any Six)

1. Study of 8086 Architecture and Execution of sample programs.
2. Write 8086 ALP to access marks of 5 subjects stored in array and find overall percentage and display grade according to it.
3. Write 8086 ALP to perform block transfer operation. (Don't use string operations) Data bytes in a block stored in one array transfer to another array. Use debugger to show execution of program.
4. Write 8086 ALP to find and count zeros, positive number and negative number from the array of signed number stored in memory and display magnitude of negative numbers.
5. Write 8086 ALP to convert 4-digit HEX number into equivalent 5-digit BCD number.
6. Write 8086 ALP to convert 5-digit BCD number into equivalent 4-digit HEX number.
7. Write 8086 ALP for following operations on the string entered by the user.
a. String length
b. Reverse of the String
c. Palindrome
8. Write 8086 ALP for following operations on the string entered by the user (Use Extern Far Procedure).
a. Concatenation of two strings
b. Find number of words, lines.
c. Find number of occurrences of substring in the given string.
9. Write 8086 ALP to initialize in graphics mode and display following object on screen.
10. Write 8086 ALP to encrypt and decrypt the given message.
11. Write 8086 ALP to perform following operations on file
a. Open File
b. Write data in the file.
c. Delete data in the file.
d. Close the file.

List of Course Projects:

1. Combinational and Sequential circuits
2. Memory Management
3. Graphics Mode
4. IOT based projects.
5. IoT based atmospheric CO2 administration.
6. IoT based flood risk predictor.
7. Simulate modern traffic control system.
8. Online Parallel Examination.

List of Course Seminar Topics:

1. Computer Architecture VS Computer Organization
2. Evolution of Computing Devices
3. Instructions types , formats and execution
4. Interrupts in Microprocessor
5. Trends in computer architecture
6. RISC Vs CISC architecture : A Case Study
7. ARM processor architecture
8. Latest Technology in Embedded systems
9. Multiplier Control Unit
10. Booth's Encoding Pattern for Fast Scalar Point Multiplication in ECC for Wireless Sensor Networks
11. Internet of Things (IoT) in 5G Wireless Communications
12. State of the art parallel processor design.
13. Memory management in mobile OS.
14. Evolution of processors.
15. Ultra SPARC Processor Architecture.

List of Course Group Discussion Topics:

1. GPU computing: CUDA
2. Memory System
3. Replacement Algorithms
4. Pipelining
5. Cache Coherance
6. Virtural Memory
7. Hazards in pipelining
8. Super Computer
9. Modern computer generations
10. Parallel computing models

List of Home Assignments:

Design:

1. Write the sequence of control steps required for the single bus organization for each of the following instructions:

   1. ADD the (immediate) number NUM to register R1

   2. ADD the contents of memory location NUM to register R1

   Assume that each instruction consists of two words. The first word specifies the operation and addressing mode, and second word contains the number NUM

2. Configure a 32 Mb DRAM chip. Consider cells to be organized in 8K X 4 array. Find out the number of address lines.

3. A set associative cache consists of 64 lines, or slots, divided into four-line sets. Main memory contains 4K blocks of 128 words each. Analyze the format of main memory addresses with proper explanation.

4. A one pipeline system takes 50 ns to process a task. The same task can be processed in 6 segment pipeline with a clock cycle of 10 ns. Determine the speedup ratio of pipeline for 100 tasks. What is maximum speedup ratio?

Case Study:

1. Micro-programmed Control Unit and Hardwired Control Unit.
2. Pipeline Hazards
3. Flynn's architectural classification scheme.
4. Modern Processor units

Survey:

1. New memory technologies and their potential impact on **architecture**
2. Virtual Memory
3. Simulation of a superscalar processor and analyzing impact of design tradeoffs
4. Cache Consistency Models in Modern Microprocessors

Blog:

1. Super Computer
2. Intel Journey
3. New Arm Interconnect technologies
4. Distributed Systems and Parallel Computing

Assessment Scheme:

Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

Text Books:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", 7th Edition, Pearson Prentice Hall Publication, ISBN 81-7758-9 93-8.
2. C. Hamacher, V. Zvonko, S. Zaky, "Computer Organization", 5th Edition, Tata McGraw Hill Publication, ISBN 007-120411-3.
3. Kai Hwang, "Advanced Computer Architecture", Tata McGraw-Hill ISBN 0-07-113342-9
4. Douglas Hall, "Microprocessors and Interfacing", 2nd Edition, Tata McGraw Hill Publications, ISBN 0-07-025742-6.
5. Peter Abel, "Assembly Language Programming," 5th Edition, Pearson Education Publications, ISBN 10:013030655.

Reference Books:

1. *Hwang and Briggs,"Computer Architecture and Parallel Processing", Tata McGraw HillPublication ISBN 13: 9780070315563.*
2. A. Tanenbaum, "Structured Computer Organization", Prentice Hall Publication, ISBN 81 –203 – 1553 – 7, 4th Edition.

MOOCs Links and additional reading material:

1. www.nptelvideos.in
2. https://www.udemy.com/
3. https://learn.saylor.org/
4. https://www.coursera.org/
5. https://swayam.gov.in/

Course Outcomes:

Upon completion of the course, post graduates will be able to –

1. Demonstrate computer architecture concepts related to design of modern processors, memories and I/Os. (2)
2. Illustrate the micro operations sequencing. (3)
3. Evaluate various alternatives in processor organization. (3)
4. Understand concepts related to memory & IO organization (2)
5. Adapt the knowledge based on Pipeline and its performance (3)
6. Design real world applications using processors. (4)

Future Courses Mapping:
Advance Computer Architecture, Advance Operating Systems

Job Mapping*:*
Application Developers, System programmer

FF No. : 654

AI2004: Software Project Development-I

Course Prerequisites: C, C++, Java, Android and Web Technologies

Course Objectives:

1. To enhance problem solving skills by independent learning
2. To emphasize learning activities that are long-term, interdisciplinary and student-centric.
3. To engage students in rich and authentic learning experiences.
4. To provide every student the opportunity to get involved individually to learn professionalism
5. To inculcate research culture and attitudes towards learning among the students.
6. To improve employability skills of students

Credits: 3   **Teaching Scheme Lab:** 2 Hours/Week

Course Relevance: Software Project Development comes under the category of Project Based Learning (PBL). For better learning experience, along with traditional classroom teaching and laboratory work-based learning, project based learning has been introduced with an objective to motivate students to learn how to solve a problem. Students may work on problems innovatively in different domains like social, technical, cultural and scientific.

Teacher's Role :

- Teacher will act as the facilitator and mentor.
- To utilize the principles of problem solving, critical thinking and metacognitive skills of the students.
- To make the individual aware of time management.
- To Help students to solve technical problems
- To assess and evaluate student performance by monitoring regularly on a weekly basis.

Recommended Guidelines :

SDP is a Project Based Learning. PBL is learning through activity. One of the faculty can be appointed as coordinator for SDP.

Following are the recommended guidelines that will work as an initiator and facilitator in the process of completion of SDP.

In the first week of commencement of semester let the coordinator create awareness about SDP (what, why, and how) among the students. Convey students expected outcomes, assessment process and evaluation criteria.

Assign mentor batch wise.

Provide guidelines for title identification (Problem can be some real life situation that needs technology solutions. This situation can be identified by meeting people around, visiting various industries, society, and institutes. The solution can be prototype, model, convertible solutions, survey and analysis, simulation, and similar).

Let students submit the problem identified in prescribed format (Title, Problem statement, domain, details of a problem undertaken, and what is need of solution to the problem)

Coordinator and Mentor can approve the problem statements based on feasibility and learning outcomes expected for second year engineering students.

Mentor is to monitor progress of the task during phases of project work. Broadly phases may include- literature survey, requirements gathering, preparing a solution, designing solution, Implementing and testing the solution.

Weekly monitoring and continuous assessment record is to be maintained by mentors.

Get the IEEE paper format as a report submitted at the end of semester.

In semester evaluation will be done by a mentor along with internal faculty as a jury and at the end of semester will be evaluated by industry experts.

Sample Software Project Statement based on Java ,C,C++, Android, Web technologies

QR Code bases contactless ordering

ATM Simulator

Drivers Booking Website

Document Scanner app

Campus canteen management system

movie ticket booking system

Covid-19 Live Statistical Analysis

...not limited to.....Faculty and students are free to include other area which meets the society requirements at large

Course Outcomes:

The student will be able to –

1. Find the real-life problem from societal need point of view

2. Compare different approaches and select the most feasible one.

3. Analyze and synthesize the identified problem from technical viewpoint

4. Design and develop an optimal and reliable solution to meet objectives

5. Validate the solution based on the criteria specified

6. Inculcate long life learning and research attitude among the students

CO PO Map:

CO1	CO2	CO3	CO4	CO5	CO6
PO1	PO2	PO4	PO8	PO12	PSO1
3	3	2	2	1	3

CO attainment levels:

CO	CO1	CO2	CO3	CO4	CO5	CO6
Level	4	2	4	5	1	3

Job Mapping: Software Engineer,Web Developer,Android Developer

AI2005: Engineering Design and Innovation III

Course Prerequisites: Problem Based Learning

Credits: 3   **Teaching Scheme Lab:** 2 Hours/Week

Course Objectives:

1. To develop critical thinking and problem solving ability by exploring and proposing solutions to realistic/social problems.

2. To Evaluate alternative approaches, and justify the use of selected tools and methods,

3. To emphasize learning activities those are long-term, inter-disciplinary and student-centric.

4. To engage students in rich and authentic learning experiences.

5. To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.

6.To develop an ecosystem to promote entrepreneurship and research culture among the students.

Course Relevance: Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Along with course based projects, curriculum can be enriched with semester long Engineering Design and Development courses, in which students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City,Smart Energy and Swaccha Bharat Abhiyan. To gain the necessary skills to tackle such projects,students can select relevant online courses and acquire skills from numerous sources under guidance of faculty and enrich their knowledge in the project domain, thereby achieving project centric learning. Modern world sustained and advanced through the successful completion of projects. In short, if students are prepared for success in life, we need to prepare them for a project-based world. It is a style of active learning and inquiry-based learning. Project based learning will also redefine the role of teacher as mentor in the learning process. The PCL model focuses the student on a big open-ended question, challenge, or problem to research and respond to and/or solve. It brings students not only to know, understand and remember rather it takes them to nalyze, design and apply categories of Bloom's Taxonomy.

SECTION-1

Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students;rather they are free to explore their creativity beyond the guideline mentioned herewith. For all courses of ED, laboratory course contents of "Trends in Engineering Technology" are designed as a ladder to extend connectivity of software technologies to solve real world problems using an interdisciplinary approach. The ladder in the form of gradual steps can be seen as below:

Industry Communication Standards, Single Board Computers and IoT, Computational Biology(Biomedical and Bioinformatics), Robotics and Drone, Industry 4.0 (Artificial Intelligence,Human Computer Interfacing, 5G and IoT, Cloud Computing, Big Data and Cyber Securityetc).

Group Structure:

· There should be a team/group of 4-5 students.

· A supervisor/mentor teacher assigned to individual groups.

· It is useful to group students of different abilities and nationalities together.

Selection of Project/Problem:

· Students must focus to initiate the task/idea .The idea inception and consideration shall

be from following areas as a real world problem:

 Health Care, Agriculture, Defense, Education, Smart City, Smart Energy, Swaccha Bharat

Abhiyan, Environment, Women Safety.

This is the sample list to start with. Faculty and students are free to include other area

which meets the society requirements at large. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning.Students design and analyze the problem/project within an articulated disciplinary subject frame/domain.

A problem can be theoretical, practical, social, technical, symbolic, cultural, and/or scientific and grows out of students' wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases. By exemplarity, a problem needs to refer back to a particular practical, scientific,social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry.

Teacher's Role in PCL :

· Teacher is not the source of solutions, rather he will act as the facilitator and mentor.

· To utilize the principles of problems solving, critical thinking and metacognitive skills of the students.

· To make the group aware about time management.

· Commitment to devote the time to solve student's technical problems and interested in

helping students to empower them better.

Student's Role in PCL:

· Students must have the ability to initiate the task/idea .They should not be mere imitators.

· They must learn to think.

· Students working in PCL must be responsible for their own learning.

· Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.

· Students in PCL are actively constructing their knowledge and understanding of the situation in groups.

· Students in PCL are expected to work in groups.

· They have to develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

Developing Inquiry Skills:

· Students in PCL are expected to develop critical thinking abilities by constantly relating:

What do they read to do? What do they want to do with that information?

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· They need to analyze information presented within the context of finding answers.

· Modeling is required so that the students can observe and build a conceptual model of the required processes.

· Use the following mechanism to maintain the track of moving towards the solution.

· How effective is …….? How strong is the evidence for ………? How clear is ……?

· What are the justifications for thinking? Why is the method chosen?

· What is the evidence given to justify the solution?

Literature Survey – To avoid reinvention of wheel:

· It is integral part of self- directed learning

· Identify the information needed to solve a given problem or issue

· Be able to locate the needed information

· Use the information to solve the given problem effectively.

· Skills required by students in information literacy include:

· How to prepare for the search? How to carry out the research

· Sorting and assessing of information in general

Use of Research Methodology: - investigation, collaboration, comprehension, application,analysis, synthesize and evaluation,Focus on following skills while working in a team to reach to solution:ollaborative learning, Interpersonal Skills, Resources Evaluation, Metacognitive Skills, Reflection Skills

Suggest an assessment Scheme:

MSE and ESE

Text Books: (As per IEEE format)

1. A new model of problem based learning. By Terry Barrett. All Ireland Society for higher education (AISHE).

ISBN:978-0-9935254-6-9; 2017

2. Problem Based Learning. By Mahnazmoallem, woei hung and Nada Dabbagh, Wiley Publishers. 2019.

Stem Project based learning and integrated science, Technology, Engineering and mathematics approach. By

Robert Robart Capraro, Mary Margaret Capraro

Reference Books: (As per IEEE format)

1. De Graaff E, Kolmos A., red.: Management of change: Implementation of problem-based and project-based

learning in engineering. Rotterdam: Sense Publishers. 2007.

2. Project management core textbook, second edition, Indian Edition , by Gopalan.

3. The Art of Agile Development. By James Shore & Shane Warden.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

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

CO1: Identify the real life problem from societal need point of view

CO2: Choose and compare alternative approaches to select most feasible one

CO3: Analyze and synthesize the identified problem from technological perspective

CO4: Design the reliable and scalable solution to meet challenges

CO5: Evaluate the solution based on the criteria specified

CO6: Inculcate long life learning attitude towards the societal problems

CO PO Map

CO1	CO2	CO3	CO4	CO5	CO6
PO2	PO3	PO3	PO2	PO1	PO3

AI2001: Advanced Data Structures

CoursePrerequisites: C/C++ (Anyprogramminglanguage)

CourseObjectives:

1. Tolearndifferentavailable datastructures.

2. Tounderstanduseofdatastructuresindifferentapplications.

3. Toanalyzecomplexityofanalgorithm.

4. Tointerpretanddiagnosethepropertiesofdatastructureswiththeirmemoryrepresentations

5. Todesigntheapplicationwiththepropertiesofappropriatedatastructure.

Credits: 5   **TeachingSchemeTheory: 3Hours**/Week

Tut: 1Hours/Week

Lab: 2Hours/Week

Course Relevance: Data structure is important in every software development to design andanalyzealgorithms.Itis usefulinall thecomputer-ITengineeringdomain,academics andindustries.

SECTION-I

Arrays, Stacks,QueuesandLinkedLists

Topicsand Contents

Arrays: Representation and application of Single and Multidimensional arrays, Time & SpaceComplexity Analysis.
Sorting Techniques: Quick Sort, Heap sort with Analysis.
Searchingtechniques: Linear Search, Binary search with Analysis.
Stack: Stack representation andImplementation using arrays and Linked lists. Applications of stack in Recursion, Expressionconversions and evaluations.
Queues: Representation and implementation using array andLinked lists, Types of queue. Applications of Queues: Job Scheduling, Josephus problem etc.
Linked Lists: Dynamic memory allocation, Singly Linked Lists, Doubly linked Lists, CircularlinkedlistsandGeneralizedlinkedlists,ApplicationsofLinkedlist.

SECTION-II

Trees, GraphsandHashing

TopicsandContents

Trees:-Basicterminology,representationusingarrayandlinkedlists.TreeTraversals:Recursive and Non recursive, Operations on binary tree. Binary Search trees (BST).

AdvancedTrees: Introduction,AVLtree,R-Btree,Btree andB+tree.

Graphs:Terminologyandrepresentation using Adjacency Matrix and Adjacency Lists, Graph Traversals: BFS andDFS.Minimum Spanning tree: Prims and Kruskal's Algorithm, Shortest Path Algorithms.

Hashing: Hashing techniques, Hash table, Hash functions. Collision handling and Collisionresolutiontechniques.

ListofTutorials:(AnyThree)
1.   Sorting Techniques: Insertion, Mergesort,Bubble, ShellSort,RadixSort.
2.   SearchingTechniques:TernarySearch,FibonacciSearch.
3.   Problemsolvingusingstack(Mazeproblem,TowerofHanoi).
4.   Expressionconversionlikeinfixtoprefixandpostfixandviceversa.
5.   PriorityQueuesandJobSchedulingAlgorithm.
6.   GeneralizedLinkedLists.
7.   ThreadedBinarytreeandStack lessTraversalsusing TBT.
8.   Band B+Tree.
9.   ApplicationsofGraph inNetworkproblems.
10.   DesignofHashingFunctionsandCollisionResolutiontechniques.

ListofPracticals: (AnySix)

1.   SortingandSearching.
2.   Stack Application(Expressionconversionetc.)
3.   QueueApplication(Jobscheduling,resourcesallocationetc.)
4.   Linkedlist.
5.   BSToperations(Create,Insert,DeleteandTraversals)
6.   VariousoperationsonBinaryTree(Mirrorimage,Height,Leafnodedisplay,Levelwisedisplayetc.)
7.   AVLandR-Btree.
8.   DFSandBFS
9.   MSTusingPrim'sandKruskal'sAlgorithm.
10.   FindingtheshortestpathinagivenGraph.

ListofProjects:
1. MazeProblem
2. Tower ofHanoi
3. PersonalDiaryManagementSystem
4. PhonebookApplication
5. QuizGame
6. SchoolBillingSystem
7. SnakeGame
8. Student RecordSystem
9. TelecomBillingSystem
10. Tic-Tac-ToeGame

List ofCourseSeminarTopics:
1. Algorithmanditscomplexity
2. Minimumspanningtreealgorithm
3. BinarySearchTreeoperations
4. Stackapplications
5. MergeandQuicksort
6. Generalizedlinkedlist
7. AVL tree
8. JosephusproblemusingQueue
9. Threadedbinarytree
10. ConstructallpossibleBSTfromNnodes

ListofCourseGroupDiscussionTopics:
1. Stackapplications
2. Queueapplications
3. singly/doubly/circularlinkedlist
4. StaticvsDynamic structures
5. Shortestpathalgorithms
6. Sortingalgorithms
7. Sortingalgorithmusing linkedlist
8. Hashingalgorithms
9. Algorithmiccomplexity
10. Graphapplications

ListofHomeAssignments:
Design:
1. Designadatadictionarybyselecting appropriatedata structures
2. Selectionofsuitabledatastructuresfor designofasocialnetworkingwebsiteproject
3. Selectionofsuitabledatastructuresfordesignofagame suchasonlinequiz
4. DesignGooglemapusingalternativedatastructures
5. DesignGraphicalcalculator/Texteditor

Case Study:
1. DataNetworkpathstorage
2. Dataminingclassifiers
3. Imageprocessingpatternstorageandmatching
4. Databasemanagement system
5. Operatingsystem

Blog
1. Current trendsinuseofdata structures
2. Threadedbinarytreeapplications
3. Well-balancedtrees
4. Optimumdatastructures
5. Adaptation indatastructures

Surveys
1. Image/Videocompression
2. Systemprograms datastorage
3. Operatingsystem
4. Networkalgorithms
5. Datamining

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentandcheck ifitcoversallaspectsofBloomsTaxonomy.

1. *HomeAssignment*
2. *MSE&ESE*
3. *Quiz*
4. *Seminar*
5. *GroupDiscussion*
6. *LAB-CourseAssignmentandProjectEvaluation*

Text Books:(*AsperIEEEformat)*

1. E. Horwitz, S.Sahani,Anderson-Freed,
FundamentalsofDataStructuresinC",,SecondEdition, UniversitiesPress.
2. Y.Langsam,M.J.Augenstein,A.M.Tenenbaum,"Datastructuresusing Cand
C++",,PearsonEducation,SecondEdition.

ReferenceBooks:*(AsperIEEEformat)*

J.Tremblay,P.soresan,"AnIntroductiontodataStructureswithapplications",,TMHPublication,2^{nd}Edition.

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:

1. To interpret and diagnose the properties of data structures with their memoryrepresentationsandtime complexityanalysis.
2. Touselineardatastructureslikestacks,queueswiththeirapplications.
3. To implementoperations likesearching,insertion, deletion, traversingmechanism etc. onvariousdatastructureswiththe helpofdynamicstoragerepresentation.
4. TodemonstratetheuseofbinarytreetraversalsandtoperformvariousoperationsonNon-lineardatastructures.
5. Toanalyzethe Graphdatastructureand to solvethe applicationsofGraphdata structures.
6. TodesigntheappropriatedatastructurebyapplyingvarioushashingTechniques.

COattainmentlevels
COLevels
CO 1-1
CO 2-2
CO 3-3
CO 4-4
CO 5-5
CO 6-2

FutureCoursesMapping:
OperatingSystem, DatabaseManagementsystemsandmostofsoftwaredevelopmentsubjects.

JobMapping:
All software developmentjobs.

AI2002::Discrete Structures and Automata Theory

CoursePrerequisites: Basic mathematics and programming

CourseObjectives:

1. Formulate and solve counting problems, problems based on recurrence relations and probability theory
2. To study graph and tree based models to be applied in real life problems
3. To design suitable computational model/s for accepting a given language
4. To compare these models with respect to their power in recognizing different types of languages

Credits: 5   **TeachingSchemeTheory:3**Hours/Week

Tut:1 Hours/Week

Lab:2 Hours/Week

Course Relevance: This course lays a strong foundation for higher studies as well as research. For higher studies, there are different courses such as 'Program Analysis and Verification' which are based on the concepts of computation theory.

For Research scholars, it would help in understanding the type and class of problems, and to solve and prove certainty of the provided solution.

It would also help software developers in building the logic of programs, exploring its mathematical proofs, generating hypothetical scenarios, designing various computing machines.

SECTION-I

Topicsand Contents

Logic and Proofs: Propositional logic, applications of propositional logic, propositional equivalences, predicates and quantifiers, rules of inference, introduction to proofs: direct, contrapositive, contradiction, counter example, principle of mathematical induction.

Elementary Discrete Structures & Basic Counting: Elementary set theory, relations, functions, basic counting principles, permutations, combinations, Pigeon-Hole Principle, generalized pigeon-hole principle, Inclusion Exclusion Principle: Counting, Euler's phi function.

Recurrence relations: Recurrence relations, modelling using recurrence relations, Fibonacci numbers, solution of linear recurrence relations with constant coefficients (homogeneous and

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inhomogeneous).

Probability Theory: Discrete Probability, Conditional Probability, Bayes Theorem, Information and Mutual Information, Applications of Combinatorics and Discrete Probability.

Graph Theory: Graphs, different representations, properties of incidence and adjacency matrices, directed/undirected graphs, connected components, degree of a vertex, paths, cycles in graph, tree, bipartite graphs (graph with only odd cycles, 2-colorable graphs), Planar graphs, Eulerian path and Eulerian circuit, Hamiltonian circuit.

SECTION-II

 TopicsandContents

Finite Automata: Automaton as a model of computation, Alphabets, Strings, Languages, Finite Automata, Deterministic Finite Automata (DFA) - Formal Definition, State Minimization algorithm, Nondeterministic finite Automata (NFA), NFA with epsilon transition.

Regular Expression: Regular expression (RE) Definition, Applications, Kleene's Theorem: Equivalence of RE and DFA, Closure properties of Regular Languages, Myhill-Nerode theorem and its applications, Pumping Lemma for regular Languages.

Grammar: Grammar, definition, Context Free Grammars (CFG), Derivation, Languages of CFG, Constructing CFG, Closure and Decision properties of Context Free Languages (CFLs). Derivation trees, Ambiguity in CFGs, Removing ambiguity, CNF, GNF, Chomsky hierarchy, Applications of CFG.

Pushdown Automata: Pushdown Automata (PDA) definition, Languages, Acceptance by final state / empty stack, Deterministic and Non-deterministic PDAs, CFG to PDA construction, Equivalence of PDA and CFG, Pumping lemma for CFLs, Context Sensitive Languages, Context Sensitive Grammars, Linear Bounded Automata.

Turing Machine: Turing Machine (TM) definition, Instantaneous Description, Language acceptance, Robustness of TM, equivalence of TM variants; Universal Turing Machine, TM as enumerator, Recursive and Recursively Enumerable languages and their closure properties, Decidability and Undecidability.

Listof Practical's: (AnySix)

1. Tower of Hanoi: Generate recurrence relation and solve.
2. Fibonacci numbers: Generate recurrence relation and solve.
3. Explore various set operations. Consider the universal set U: ={0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15}. Consider 2 sets A and B. Use the randomly generated sets to determine the following. A ∪ B , A ∩ B, A', A ∩ (B ∩ C), A − B , A' ∩ B , (A ∪ C) ∩ B
4. Problems based on Conditional Probability.
5. Exercises on conversion of Regular expression to DFA and vice versa
6. Problems on NFA to DFA conversion.
7. Numerical based on minimization and equivalence of Automata
8. Proof of Closure properties of Regular Languages
9. Problems on checking of Ambiguity of Grammar and Simplification of CFGs
10. Problems on Normal forms of CFGs: CNF and GNF
11. Problems based on PDA construction
12. Problems on Turing machine design

List ofProjects:

List ofCourseSeminarTopics:
1. Set Theory and its applications in Artificial Intelligence
2. Different Counting principles
3. Applications of Bipartite graphs in biology and medicine
4. Applications of Probability theory in risk assessment and modeling
5. Hamiltonian graph vs Eulerian graph
6. Zero divisors and Integral domain
7. DFA and NFA
8. Regular Expressions
9. Minimization of DFA
10. Myhill-Nerode Theorem
11. Context Free Grammar
12. Turing Machine
13. Pushdown Automata
14. Recursive and Recursively Enumerable Languages
15. Universal Turing Machine

16. Applications of DFA and NFA

ListofCourseGroupDiscussionTopics:
1. Need of Graphs in real life applications
2. Applications of Set Theory
3. Applications of Euler's Theorem in counting remainders
4. Homogeneous Vs non-homogeneous recurrence relation
5. Pigeonhole principle and its applications
6. NFA vs DFA
7. Power of Automata
8. Need of Automata in Computer Science
9. Ambiguity in Grammar
10. Mealy vs Moore Machine
11. CNF vs GNF
12. CFL and Non CFL and its applications
13. Power of Turing machine and Linear Bounded Automata
14. Closure Properties of CFL
15. Applications of Automata

ListofHomeAssignments:
Design:
1. Design of social network using graphs
2. Design of railway network using graph
3. Design of POC MAN Game
4. Design Switching Circuit
5. Digital Logic Design using DFA
6. Digital Logic Design using NFA
7. Design Multitape TM for Palindrome
8. Design PDA for String Copy
9. Design LBA for real world application
10. Design parser to recognize string

Case Study:
1. Discuss ways in which telephone numbering plan can be extended to accommodate the rapid demand for more telephone numbers. For each numbering plan, find how different telephone numbers can be formed
2. Investigate the properties of web graph, analyse web graphs by correlating the graph theoretic concepts with properties of web graph
3. Study any one real life application where DFA and NFA is used, study its merits and demerits
4. Study any one example of Turing machine with Multitape and its benefits
5. Study any one real life applications of PDA, discuss its advantages and limitations
6. Study all Automata and discuss their power
7. Study Membership Algorithm and discuss its applications
8. Study of Chomsky Hierarchy
9. Study of Pattern Matching Algorithm
10. Study of Myhill-Nerode Theorem

11. Pumping Lemma
12. Finite Automata in Markov Model

Blog
1. Proofs to differentiate direct, contrapositive, contradiction with suitable examples
2. Importance of discrete mathematics in real life. Write an article related to any four domains where discrete mathematics is dominantly used
3. How graph theory is used as a technology in recent trends? Graph theory and its applications (atleast 8)
4. Significance of Combinatorics and Discrete Probability in today's world
5. How search engines use graph concepts?
6. Automata Theory Limitations and Applications
7. Pumping Lemma
8. Kleene's star and Positive Closure
9. Regular Expression and its Closure Properties
10. PDA vs TM and its Advantages

Surveys
1. Recurrence relations for dynamic programming
2. Graphs in computer networks
3. Probability theory for weather forecasting
4. Game Theory: an application of probability
5. Graph theory for Machine learning problem
6. Pattern matching algorithm
7. Evolution of Computational Models
8. Applications of Computer Theory in real life
9. Applications where Automata Theory is Beneficial
10. Power of Turing Machine
11. Real life examples to find ambiguity in it and its elimination
12. Closure properties of Regular and Context Free Languages
13. Role of Non Determinism
14. Working of Parser
15. Evolution of Models of Computations

SuggestanassessmentScheme:
Suggestany Assessment scheme that isbestsuitedforthecourse.Ensure360 degree assessment andcheck ifitcoversallaspectsofBloomsTaxonomy.

Text Books:*(AsperIEEEformat)*

1. *Kenneth Rosen , "Discrete Mathematics and its applications", 7ᵗʰ Edition, McGraw-Hill, ISBN 0–07–338309–0.*
2. *Alan Tucker ,"Applied Combinatorics", 6ᵗʰ Edition, Wiley Publishing company.*
3. *C. L. Liu and D. P. Mohapatra, "Elements of Discrete Mathematics", 4th Edition, McGraw-Hill*
4. *Hopcroft J, Motwani R, Ullman, Addison-Wesley, "Introduction to Automata Theory, Languages and Computation", Second Edition, ISBN 81-7808-347-7.*

5. *Michael Sipser, , "Introduction to Theory of Computation", Third Edition, Course Technology, ISBN-10: 053494728X.*

ReferenceBooks:*(AsperIEEEformat)*

1. *Peter J. Cameron, "Combinatorics: Topics, techniques, algorithms", Cambridge University Press*
2. *Reinhard Diestel , "Graph Theory", 5th Edition, Springer Verlag Publishing Company*
3. *Douglas B. West ,"Introduction to Graph Theory", Prentice-Hall publishers*
4. *Edgar G. Goodaire, Michael M. Parmenter, "Discrete Mathematics with Graph Theory", 3rd Edition, Pearson Education*
5. *John C. Martin," Introduction to Languages and The Theory of Computation", Fourth Edition, McGraw Hill, ISBN 978-0-07-319146-1.*

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:

1. Students should be able to solve counting problems and problems based on recurrence relations
2. Students should be able to apply knowledge of Graph and Tree based models to solve real life problems
3. Students should be able to calculate discrete probabilities
4. Students should be able to design Finite Automata / Turing machine for given computational problems
5. Students should be able to correlate given computational model with its Language
6. Students should be able to analyse power of different computational models

COattainmentlevels

COLevelsCO

FutureCoursesMapping:

- Data structures
- Problem solving
- Design and Analysis of Algorithms
- Compiler Design
- Machine Learning

JobMapping:
Application developer, System software developer, Data science engineer, Machine learning architect

AI2003::Computer Network

Course Prerequisites: Fundamentals of Computer, C/C++ programming.
Course Objectives:
1. Understand the importance of Computer Network and its usage.
2. Study error control and flow control techniques.
3. Solve real-world problems in the context of today's internet (TCP/IP and UDP/IP).
4. Distinguish and relate various physical Medias, interfacing standards and adapters.
5. Implement mathematically and logically the working of computer protocols in abstract.

Credits: 4   **Teaching Scheme Theory:** 3 Hours/Week
                                                    Tut: 1 Hours/Week
                                                    Lab: 2 Hours/Week

Course Relevance: A system of interconnected computers and computerized peripherals such as printers is called computer network. This interconnection among computers facilitates information sharing among them by using data communication. The main objective of computer network is to enable seamless exchange of data between any two points in the world. This course will explore common network services and protocols such as email, web services etc Networking is an evergrowing domain in which there is a constant need of support. Networks are becoming progressively more and more convoluted as the technology is advancing and flourishing.

SECTION-I

Topics and Contents
Introduction: Introduction to computer network, LAN, MAN, WAN, PAN, Ad-hoc Networks, Network Architectures- Client-Server, Peer To Peer, Network Topologies- Bus, ring, tree, star, mesh, hybrid. Communication Models- OSI Model, TCP/IP Model, Design issues for layers.
Physical Layer: Transmission media- Guided media, unguided media. Transmission Modes- Simplex, Half-Duplex and Full-Duplex. Network Devices- Hub, Repeater, Bridge, Switch, Router, Gateways and Brouter. Line Coding Schemes- Unipolar, Polar and Bipolar. Modulation- Narrow band signal, spread spectrum signal, FHSS, DSSS.
Data Link Layer:Logical Link Layer- Services to Network Layer, Framing, Error Control and Flow Control. Framing in LLC- framing challenges, types of framing. Error Control in LLC- error detection, error correction, Parity Bits, Hamming Codes (11/12-bits) and CRC. Flow Control Protocols- Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. WAN Connectivity- PPP and HDLC.
Medium Access Control: Channel Allocation-Static and Dynamic, Multiple Access Protocols- Pure

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and Slotted ALOHA, CSMA, WDMA, IEEE 802.3 Standards and Frame Formats, CSMA/CD, Fast Ethernet, Gigabit Ethernet, IEEE 802.11a/b/g/n and IEEE 802.15 and IEEE 802.16 Standards, Frame formats, CSMA/CA

SECTION-II

Topics and Contents

Network Layer: Switching techniques, IP Protocol, IPv4 and IPv6 addressing schemes, Subnetting,

NAT, CIDR, ICMP, Routing Protocols- Distance Vector, Link State, Path Vector, Routing in

Internet- RIP,OSPF, BGP, Congestion control and QoS, MPLS, Mobile IP, Routing in MANETAODV, DSR.

Transport Layer: Services, Berkley Sockets, Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, TCP, TCP Timer management, TCP Congestion

Control, Real Time Transport protocol (RTP), Stream Control Transmission Protocol (SCTP), Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless.

Application Layer: Domain Name System (DNS), Hyper Text Transfer Protocol (HTTP), Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, Dynamic Host Control Protocol (DHCP), Simple Network Management Protocol (SNMP).

List of Practical's: (Any Six)

1. Study and implement various networking commands on terminal.
2. Use Socket programming to create Client and Server to send Hello message.
3. Write a program for error detection and correction for 7/8 bits ASCII codes using Hamming Codes or CRC. Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer-to-peermode. (50% students will perform Hamming Code and others will perform CRC)
4. Write a program to simulate Go back N and Selective Repeat Modes of Sliding Window Protocol in peer-to-peer mode
5. Write a program to find class and type of a given IP address.
6. Write a program to demonstrate subnetting and find the subnet masks.
7. Write a program using TCP socket for wired network for following: a. Say Hello to Each

other (For all students) b. File transfer (For all students) c. Calculator (Arithmetic) (50% students) d. Calculator (Trigonometry) (50% students)

8. Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines.

9. Write a program to implement: a. Network Routing: Shortest path routing, AODV. b. Analysis of congestion control (TCP and UDP).

10. Write a program to analyse following packet formats captured through Wireshark for wired networks. 1.Ethernet 2. IP 3.TCP 4. UDP

List of Projects:

1. Write a program using TCP sockets for wired networks to implement a. Peer to Peer Chat b. Multi User Chat Demonstrate the packets captured traces using Wireshark Packet Analyzer

Tool for peer-to-peer mode.

2. Implementation of shortest path protocol

3. Implementation of string encryption and decryption

4. Implementation of character stuffing and destuffing

5. Execution and analysis of Network commands

6. To find out details of network from IP addressing scheme using 'C' code

7. Implement real time Internet route optimization.

8. Implement Broadcast Server System.

9. Implement a real time voting System.

10. Real time packet capture and analysis for malwares in wireless networks.

List of Course Seminar Topics:

1. Asynchronous Transfer Mode

2. Need Of Multiplexing for Signal Modulation

3. TDM with PAM a case study

4. Noise signal

5. Basic Network Protocols

6. Manchester Vs Differential Manchester coding technique

7. Amplitude Shift Keying: Working and Applications

8. Nyquist Sampling Theorem

9. CDMA

10. Line coding Techniques with example

List of Course Group Discussion Topics:

1. TCP/IP Model
2. Mobile IP
3. Congestion Control and QoS
4. Wireless Technology for Short range and long range
5. Application Protocols and its security
6. IP Protocols
7. Data Communication Issues in IP Networks and Solutions to it
8. Congestion control in hybrid networks
9. Issues in Real time Audio and video transmission protocol.
10. IPV6

List of Home Assignments:

Design:

1. Enumerate the challenges in Line coding. Draw the line code for the sequence 010011110 using Polar NRZ-L and NRZ-1 schemes.
2. 2.Design the procedure to configure TCP/IP network layer services.
3. Simulation of Routing Protocols using NS2
4. Simulation of FTP based Protocols using CISCO packet Tracer/ NS2
5. Simulation of Congestion Control Protocols Using NS2

Case Study:

1. Amplitude and Frequency Modulation Technique
2. Digital to Analog and Analog to Digital converters
3. Study of Various VPNs
4. IoT Solutions to Current Network Requirement
5. Unix Solutions for Broadcast System

Blog:

1. Communication Protocol
2. Emerging Trends in Computer Networks
3. Use of IOT in Networks
4. Cloud based Network Solutions for real world problems
5. Recent Trends in Computer Security

Surveys:

1. 1.Survey of wireless Technologies
2. Survey of Congestion control methodologies
3. Survey of Bluetooth Technology
4. Survey of Virtual Private Networks

5. Survey of ADHOC Networks

Suggest an assessment Scheme:

Suggest any Assessment scheme that is best suited for the course. Ensure 360 degree assessment
and check if it covers all aspects of Blooms Taxonomy.

1. MSE
2. ESE
3. LAB
4. VIVA
5. PPT/GD

Text Books:*(As per IEEE format)*

*1. James F. Kurose, and Keith W. Ross," A Top-Down Approacht," 4th edition, Publisher:
Addison-Wesley ISBN: 0-321-49770-8*

2. Behrouz A. Forouzan ,"Data Communication and Networking", 4th edition, Tata McGraw Hill

3. Andrew S. Tanenbaum, "Computer Networks" ,5th Edition, Pearson Education

Reference Books:*(As per IEEE format)*

*1. Kurose, Ross,"Computer Networking a Top Down Approach Featuring the Internet‖", Pearson;
6th edition (March 5, 2012), ISBN-10: 0132856204*

*2. Holger Karl and Andreas Willig,"Protocols and Architectures for Wireless Sensor Network",
Wiley, ISBN: 0-470-09510-5*

*3. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and
Protocols", Prentice Hall, 2004*

Moocs Links and additional reading material:

1. www.nptelvideos.in

2. https://www.my-mooc.com/en/categorie/computer-networking

3. www.udemy.com

Course Outcomes:

CO attainment levels

Future Courses Mapping:
Internet of Things

Job Mapping:
Application developer, System software developer, Data science engineer, Machine learning architect

AI2006: Database Management And Data mining

Course Prerequisites: Data structure, Computer Programming

Course Objectives:

1. To understand fundamental concepts and principles of data bases ,database management system, including the architecture, design and functionality.

2. To learn data modeling concepts (E-R and Class diagrams) used in database development.

3. To normalize the databases up to a given normal form and query the database using SQL/PLSQL

4. To learn classification fundamentals and applications.

5. To understand clustering of data and analysis

6. To do association analysis/mining from a given data set

Credits: 4   **Teaching Scheme**   **Theory: 3** Hours/Week
                                                         Tut: 1 Hour/week
                                                         Lab: **2** Hours/Week

Course Relevance: This course widely applicable in all software industries to manage and mine data

SECTION-I

Topics and Contents

Database fundamentals: -Database and Need for DBMS, Characteristics of DBMS, Database Users, 3-tier architecture of DBMS, Data Models, Views of data-schemas and instances, Data Independence, Conventional data models & systems

ER modeling: Entities, Relationships, Representation of entities, attributes, relationship, attributes, relationship sets, Generalization, aggregation, Structure of relational Database and   different   types of   keys, Expressing   M:N   relation.
Relational data model- basic concepts, constraints, and Relational database language - relational algebra, Codd's rules,

SQL and PL/SQL:-Data definition Language   in SQL ,Views and queries in SQL .Specifying constraints and indexes in SQL, PL/SQL basic programs-function, procedure

SECTION-II

Topics and Contents

Normalization- needof normalization, ER to Relational, Functional dependency, Inference Rules for Functional Dependencies ,Closure of functional dependencies, Normal forms 1NF, 2NF, 3NF and Checking of lossless join , dependency preserving decomposition

Transaction Processing- Concept of transaction, ACID properties, states of transaction, serializibility-conflict and view, Concurrency control - Locking techniques, Time stamp ordering

Data mining:

Basic concepts, introduction to pattern, pattern class, definitions of classification and clustering

Classification:

Basic concepts and techniques, decision tree classifier, nearest neighbor and K-NN classifier, over fitting and under fitting, concept of outliers.

Clustering:

Basic concepts and algorithms, c-means clustering, types of clustering, evaluation of clustering, confusion matrix

Association analysis:

Basic concepts, market basket analysis, support, confidence and association rule mining

List of Tutorials:

1. Data Visualization
2. Distances and Projections
3. Singular Value Decomposition
4. Principal Component Analysis
5. Optimization
6. Normal & Binomial Distribution
7. Hypothesis Testing
8. ANOVA test
9. Linear Regression
10. Logistic Regression
11. Nearest Neighbor Classification
12. Decision Trees based classification
13. Naive Bayes classification
14. Clustering
15. Evaluation of model performance
16. Bagging & Boosting approaches

List of Practicals: (Any Six - Any 3 out of 1 to 5 and any 3 out of 6 to 10)

1. Create tables using create table command, define table level and column level constraints, Commands for table management (DDL)- Alter table , Drop table, DML -commands -Insert, Update, Delete records and truncate
   2. Select command with operators like arithmetic, comparison, logical Query Expression operators. Ordering the records with order by ,Grouping the records using group by clause, Aggregate functions: Avg, max, min, sum, count and etc
3. Use of set operations : Union, Union all, intersect, minus and join concept: Simple, equi, non equi, self, outer join and Sub queries.
4. Creation and use of DB objects like Sequence, Synonym, View: create, update, drop, Index
5. Create and execute basic programs based on PL / SQL- function and procedure.
6. Implementation of K-NN classifier for fisher iris data set and performance evaluation
7. Implementation of c-means clustering for a given data set and performance evaluation
8. Implementation of finding association rules mining from a given data set
9. Implementation of Decision tree classifier for fisher iris data set and performance evaluation.
10. Using nearest neighbor classifier for a given data set
11. Any other assignments suggested by the instructor

List of Projects:

From any one of the sub-domain

1. DBMS- Design a backend for a real DBMS application.

Project: Design and develop an application based on Database management system eg. School management system, Inventory management system. Each student will opt for the different system to be designed and implemented using SQL and PL/SQL. Across the batch similar topics can be allowed with prior permission of the teacher.

2. Use of classification, clustering and association mining for real data sets.

Use any data set from UCI repository or kaggle for classification/clustering or hybrid classification/clustering

List of Course Seminar Topics:

1. Cloud databases.
2. Codd's Rules and their uses
3. Techniques of cluster analysis
4. Fast clustering techniques
5. Fuzzy classifiers
6. Parallel databases
7. Distributed databases
8. Modern concurrency control protocols
9. Embedded SQL- need and
10. Trigger and Cursors in Oracle
11. NoSQL- MongoDB
12. Algorithm of association rule mining
13. Neural network classifiers
14. SVM classifier
15. Some other topics decided by instructor

List of Course Group Discussion Topics:

1. Concurrency and recovery mechanism in DBMS
2. Security mechanism in DBMS
3. Avoiding over fitting and under fitting in classifiers
4. Fuzzy clustering technique
5. Database backup and recovery
6. Types of data considered for data mining
7. Features of MongoDB
8. Linear regression for prediction
9. Drawbacks of K-NN classifier
10. Comparison of SQL and No Sql
11. Introduction to MongoDB
12. Random forest classifier
13. Logistic regression for classification
14. Some other topics decided by instructor

List of Home Assignments:

Design:

1. 1.Design a Database system for a School
2. 2.Design a Database system for a Gym
3. 3.Design a Database system for a shop
4. 4.Design a Database system for a Hotel
5. 5.Design a system for handwritten character classification using K-NN classifier
6. 6.Design a clustering approach to reason about handwritten character shapes
7. Design a system to find association rules from a given data set
8. Some other topics decided by instructor

Case Study:
1. A priory algorithm for association mining with a real example
2. IBM's DB2
3. MySQL
4. ARTool for association rule mining (https://www.cs.umb.edu/~laur/ARtool/)
5. MongoDB
6. Classification in IoT
7. Clustering in visual pattern analysis
8. Document classification
9. Some other topics decided by instructor

Blog
1. Hybrid classification and clustering approach
2. Future of databases
3. Types of Concurrency control protocols and their comparison
4. Future of Data mining
5. Fast classification methods for higher dimensional data
6. Multiple databases a new trend
7. Big data management
8. Fast clustering approaches for higher dimensional data
9. Big data storage and processing
10. Some other topics decided by instructor

Surveys
1. Database migration tools
2. Development of fuzzy clustering
3. Development in classification approaches
4. Embedded SQL
5. New SQL developmental phases
6. Data sampling techniques
7. Methods of dimensionality reduction of data sets
8. Big data storage
9. Some other topics decided by instructor

Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.
MSE PPT Presentation   ESE   GD   Viva   Lab assignments +Course Project

Text Books: *(As per IEEE format)*

1. *A. Silberschatz, Henry F. Korth, and S. Sudarshan, Database System Concepts, 6th editiion, McGraw Hill, 2010 ISBN 0-07-352332-1*
2. *RamezElmasri, Shamkant B. Navath, Fundamentals of Database System; 6th Edition;Pearson*
3. *Koch, George, Oracle: The Complete Reference, Tata McGraw Hill Publication, 2006, ISBN 0 – 07 – 063414 – 9*
4. *Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, Introduction to data mining, Pearson, 2nd Edition, 2019*

Reference Books: *(As per IEEE format)*

1. *Jeffrey D. Ullman and Jennifer Widom `A First Course in Database Systems , Prentice Hall, Second Edition, 2002.*
2. *Raghu Ramakrishnan, Johannes Gehrke; Database Management Systems, 3rd Edition ; McGraw Hill Education*
3. *RamezElmasri and Shamkant B. Navathe. 2015. Fundamentals of Database Systems (7th. ed.). Pearson.*
4. *Martin Gruber, Understanding SQL, BPB publication,2003*
5. *Scott Urman, Oracle 9 I PL/SQL Programming, Oracle Press,2005*
6. *Ivan Bayross, SQL, PL/SQL The Programming Language Of Oracle, BPB Publication, 2006, ISBN: 8176560723*
7. *Jiawei Han, Micheline Kamber, Jian pei, Data mining- concepts and techniques, Morgan Kaufman, 2011*

Moocs Links and additional reading material:
1. https://www.db-book.com/db6/
2. https://www.lucidchart.com/pages/examples/er-diagram-tool
3. https://hanj.cs.illinois.edu/bk3/bk3_slidesindex.htm

Course Outcomes:

The student will be able to –

1. Design data models as per data requirements of an organization
2. Synthesize a relational data model up to a suitable normal form
3. Develop a database system using relational queries and PL/SQL objects
4. Apply indexing techniques and query optimization strategies
5. Understand importance of classification and clustering techniques
6. Adapt to association rule mining from data sets

CO attainment levels

CO1-2

CO2-2

CO3-3

CO4-3

CO5-4

CO6-4

Future Courses Mapping:

Data warehouse and Data mining, Advanced DBMS, Data Science, Web enabled databases, Parallel databases, NoSQL DB, New SQL DB, Database System Administration, Database Performance Tuning, Big data mining, Parallel data mining

Job Mapping:

Database programmer, DB system Administrator, Database Designer, Database Application Designer- Front end and Back end, DB -Query optimization, SQL and Pl/SQL developer, Embedded SQL Developer, BI analyst, Data Modelers, ETL Analyst

FF No. : 654

AI2004: Software Project Development-II

Course Prerequisites: C, C++, Java, Android and Web Technologies

Course Objectives:

1. To enhance problem solving skills by independent learning
2. To emphasize learning activities that are long-term, interdisciplinary and student-centric.
3. To engage students in rich and authentic learning experiences.
4. To provide every student the opportunity to get involved individually to learn professionalism
5. To inculcate research culture and attitudes towards learning among the students.
6. To improve employability skills of students

Credits: 3   **Teaching Scheme Lab:** 2 Hours/Week

Course Relevance: Software Project Development comes under the category of Project Based Learning (PBL). For better learning experience, along with traditional classroom teaching and laboratory work-based learning, project based learning has been introduced with an objective to motivate students to learn how to solve a problem. Students may work on problems innovatively in different domains like social, technical, cultural and scientific.

Teacher's Role :

- Teacher will act as the facilitator and mentor.
- To utilize the principles of problem solving, critical thinking and metacognitive skills of the students.
- To make the individual aware of time management.
- To Help students to solve technical problems
- To assess and evaluate student performance by monitoring regularly on a weekly basis.

Recommended Guidelines :

SDP is a Project Based Learning. PBL is learning through activity. One of the faculty can be appointed as coordinator for SDP.

Following are the recommended guidelines that will work as an initiator and facilitator in the process of completion of SDP.

In the first week of commencement of semester let the coordinator create awareness about SDP (what, why, and how) among the students. Convey students expected outcomes, assessment process and evaluation criteria.

Assign mentor batch wise.

Provide guidelines for title identification (Problem can be some real life situation that needs technology solutions. This situation can be identified by meeting people around, visiting various industries, society, and institutes. The solution can be prototype, model, convertible solutions, survey and analysis, simulation, and similar).

Let students submit the problem identified in prescribed format (Title, Problem statement, domain, details of a problem undertaken, and what is need of solution to the problem)

Coordinator and Mentor can approve the problem statements based on feasibility and learning outcomes expected for second year engineering students.

Mentor is to monitor progress of the task during phases of project work. Broadly phases may include- literature survey, requirements gathering, preparing a solution, designing solution, Implementing and testing the solution.

Weekly monitoring and continuous assessment record is to be maintained by mentors.

Get the IEEE paper format as a report submitted at the end of semester.

In semester evaluation will be done by a mentor along with internal faculty as a jury and at the end of semester will be evaluated by industry experts.

Sample Software Project Statement based on Java ,C,C++, Android, Web technologies

QR Code bases contactless ordering

ATM Simulator

Drivers Booking Website

Document Scanner app

Campus canteen management system

movie ticket booking system

Covid-19 Live Statistical Analysis

...not limited to.....Faculty and students are free to include other area which meets the society requirements at large

Course Outcomes:

The student will be able to –

1. Find the real-life problem from societal need point of view

2. Compare different approaches and select the most feasible one.

3. Analyze and synthesize the identified problem from technical viewpoint

4. Design and develop an optimal and reliable solution to meet objectives

5. Validate the solution based on the criteria specified

6. Inculcate long life learning and research attitude among the students

CO PO Map:

CO1	CO2	CO3	CO4	CO5	CO6
PO1	PO2	PO4	PO8	PO12	PSO1
3	3	2	2	1	3

CO attainment levels:

CO	CO1	CO2	CO3	CO4	CO5	CO6
Level	4	2	4	5	1	3

Job Mapping: Software Engineer,Web Developer,Android Developer

FF No. : 654

AI2005: Engineering Design and Innovation-II

Course Prerequisites: Problem Based Learning

Course Objectives:

1. To develop critical thinking and problem solving ability by exploring and proposing solutions to realistic/social problems.

2. To Evaluate alternative approaches, and justify the use of selected tools and methods,

3. To emphasize learning activities those are long-term, inter-disciplinary and student-centric.

4. To engage students in rich and authentic learning experiences.

5. To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.

6.To develop an ecosystem to promote entrepreneurship and research culture among the students.

Credits: 4   **Teaching Scheme Theory: 3** Hours/Week

Lab:2 Hours/Week

   Course Relevance: Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Along with course based projects, curriculum can be enriched with semester long Engineering Design and Development courses, in which students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. To gain the necessary skills to tackle such projects, students can select relevant online courses and acquire skills from numerous sources under guidance of faculty and enrich their knowledge in the project domain, thereby achieving project centric learning. Modern world sustained and advanced through the successful completion of projects. In short, if students are prepared for success in life, we need to prepare them for a

project-based world. It is a style of active learning and inquiry-based learning. Project based

learning will also redefine the role of teacher as mentor in the learning process. The PCL model

focuses the student on a big open-ended question, challenge, or problem to research and respond

to and/or solve. It brings students not only to know, understand and remember rather it takes

them to analyze, design and apply categories of Bloom's Taxonomy.

SECTION-I
Topics and Contents   Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. For all courses of ED, laboratory course contents of "Trends in Engineering Technology" are designed as a ladder to extend connectivity of software technologies to solve real word problem using interdisciplinary approach. The ladder in the form of gradual steps can be seen as below: Industry Communication Standards, Single Board Computers and IoT, Computational Biology (Biomedical and Bioinformatics), Robotics and Drone, Industry 4.0 (Artificial Intelligence, Human Computer Interfacing, 5G and IoT, Cloud Computing, Big Data and Cyber Security etc). Group Structure: · There should be team/group of 4-5 students. · A supervisor/mentor teacher assigned to individual groups. · It is useful to group students of different abilities and nationalities together. Selection of Project/Problem: · Students must focus to initiate the task/idea .The idea inception and consideration shall

be from following areas as a real world problem:

Health Care, Agriculture, Defense, Education, Smart City, Smart Energy, Swaccha Bharat Abhiyan, Environment, Women Safety.

This is the sample list to start with. Faculty and students are free to include other area which meets the society requirements at large.

The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. Students design and analyze the problem/project within an articulated disciplinary subject frame/domain.

· A problem can be theoretical, practical, social, technical, symbolic, cultural, and/or scientific and grows out of students' wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases.

· By exemplarity, a problem needs to refer back to a particular practical, scientific, social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry.

Teacher's Role in PCL :

· Teacher is not the source of solutions rather he will they act as the facilitator and mentor.

· To utilize the principles of problems solving, critical thinking and metacognitive skills of the students.

· To aware the group about time management.

· Commitment to devote the time to solve student's technical problems and interested in helping students to empower them better.

Student's Role in PCL:

· Students must have ability to initiate the task/idea .they should not be mere imitators.

· They must learn to think.

· Students working in PCL must be responsible for their own learning.

· Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.

· Students in PCL are actively constructing their knowledge and understanding of the situation in groups.

· Students in PCL are expected to work in groups.

· They have to develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

 Developing Inquiry Skills:

· Students in PCL are expected to develop critical thinking abilities by constantly relating:

What they read to do? What they want to do with that information?

· They need to analyze information presented within the context of finding answers.

· Modeling is required so that the students can observe and build a conceptual model of the required processes.

· Use following mechanism to maintain the track of moving towards the solution.

· How effective is …….? How strong is the evidence for ………? How clear is ……?

· What are the justifications for thinking? Why is the method chosen?

· What is the evidence given to justify the solution?

Literature Survey – To avoid reinvention of wheel:

· It is integral part of self- directed learning

· Identify the information needed to solve a given problem or issue

· Be able to locate the needed information

· Use the information to solve the given problem effectively.

· Skills required by students in information literacy include:

· How to prepare the search? How to carry out the research

· Sorting and assessing of information in general

Use of Research Methodology: - investigation, collaboration, comprehension, application,

analysis, synthesize and evaluation

Focus on following skills while working in a team to reach to solution:

· Collaborative learning

· Interpersonal Skills

· Resources Evaluation

· Metacognitive Skills

 Reflection Skills

SECTION-II

EDI Sample Case Studies : -

1) Design of bioinformatics library using CPython for Next-generation Sequencing processing and analysis

2) Design of bioinformatics library using CPython for Next-generation Sequencing processing and analysis for SAM and BAM processing and analysis

3) Design of bioinformatics library using CPython for Next-generation Sequencing processing and analysis for Gnome NGS processing and analysis

4) Design of bioinformatics library using CPython for Next-generation Sequencing processing and analysis for population genetics simulation

5) Design of bioinformatics library using CPython for Next-generation Sequencing processing and analysis for proteomics processing and analysis

...not limited to.....Faculty and students are free to include other area which meets the society requirements at large.

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Bloom's Taxonomy.

Higher levels of the Booms Taxonomy - analyze, apply, evaluate and create.

Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE Review(50 Marks) and ESE Review(100 Marks) with Jury and Weekly meetings with the project guide

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Text Books: *(As per IEEE format)*

1. A new model of problem based learning. By Terry Barrett. All Ireland Society for higher education (AISHE).

ISBN:978-0-9935254-6-9; 2017

2. Problem Based Learning. By Mahnazmoallem, woei hung and Nada Dabbagh, Wiley Publishers. 2019.

3.Stem Project based learning and integrated science, Technology, Engineering and mathematics approach. By Robert Robart Capraro, Mary Margaret Capraro

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Reference Books: *(As per IEEE format)*

1. De Graaff E, Kolmos A., red.: Management of change: Implementation of problem-based and project-based

learning in engineering. Rotterdam: Sense Publishers. 2007.

2. Project management core textbook, second edition, Indian Edition , by Gopalan.

3. The Art of Agile Development. By James Shore & Shane Warden.

Moocs Links and additional reading material:
1. www.nptelvideos.in

Course Outcomes:
The student will be able to –

1. Identify the projects relevant societal needs
2. Map the technologies learned with the project needs
3. Apply the technological knowledge to design various feasible solution
4. Select best possible possible solution solution to solve a the problem
5. Develop/Fabricate a working model of proposed solution
6. Testing and validate product performance

CO attainment levels
CO1-2
CO2-2
CO3-3
CO4-3
CO5-4
CO5-4
CO6-4

Future Courses Mapping:

Major Project

Job Mapping:

Software Engineer, Software Developer, IT Engineer

TYAI&DS Module-V (B21Pattern)

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
1	AI3001	**Artificial intelligence**	3	2	1	5
2	AI3002	**Operating system**	3	2	1	5
3	AI3003	**Statistical inference**	3	2	1	5
4	AI3004	**Cloud computing**	3	2	0	4
5	**HONOUR**	**Machine learning**	3	2	1	5
6	AI3005	**Engineering design and innovation – iii**	0	0	0	4
		Total	15	10	4	28

TYAI&DS Module-VI (B21Pattern)

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
1	AI3010	**Complexity & algorithms**	3	2	1	5
2	AI3011	**Deep learning**	3	2	1	5
3	AI3012	**Image processing & computer vision**	3	2	1	5
4	AI3013	**Business intelligence**	3	2	0	4
5	**HONOUR**	**Project**	3	2	1	5
6	AI3014	**Engineering design and innovation – iii**	0	0	0	4
		Total	15	10	4	28

AI3001: Artificial Intelligence

Course Prerequisites: Data structures, Computer programming

Course Objectives:

To make students

1. Familiar with basic principles of AI

2. Capable of using heuristic searches

3. Aware of knowledge-based systems

4. Able to use fuzzy logic and neural networks

5. Learn various applications domains of AI

Credits: 5   **TeachingSchemeTheory:3**Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance: This course is highly applied in many scientific and engineering disciplines.

SECTION-I
Topics and Contents   **Fundamentals of Artificial Intelligence**   Introduction,A.I.Representation,Non-AI&AITechniques,Representation of Knowledge, Knowledge Base Systems, State Space Search, Production Systems, Problem Characteristics, types of production systems, Intelligent Agents and Environments, concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation   **Uninformed Search Strategies**   Formulation of real-world problems, Breadth First Search, Depth First Search, Depth LimitedSearch,IterativeDeepeningDepthFirstSearch,BidirectionalSearch,ComparisonofUninfo rmedsearchStrategies,Searchingwithpartialinformation,Sensor-lessproblems,

Contingency problems.

Informed Search Strategies

Generate&test,HillClimbing,BestFirstSearch,A*andAO*Algorithm,Constraintsatisfaction,Gameplaying:MinimaxSearch,Alpha-BetaCutoffs,WaitingforQuiescence

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SECTION-II

Topics and Contents

Knowledge Representation

Knowledge based agents, Wumpus world. Propositional Logic: Representation, Inference,ReasoningPatterns,Resolution,ForwardandBackwardChaining.FirstorderLogic:Representation, Inference, Reasoning Patterns, Resolution, Forwardand Backward Chaining.Basics of PROLOG: Representation, Structure, Backtracking. Expert System: Case study ofExpert SysteminPROLOG

Introduction to Planning and ANN

Blocks world, STRIPS, Implementation using goal stack, Introduction to Neural networks:-basic, comparison ofhuman brain and machine, biological neuron, general neuron model,activationfunctions,Perceptronlearningrule,applicationsandadvantagesofneuralnetworks.Briefintroductiontosingle layerandmultiplayernetworks.

Uncertainty

Non Monotonic Reasoning, Logics for Non Monotonic Reasoning, Justification based TruthMaintenance Systems, Semantic Nets, Statistical Reasoning, Fuzzy logic: fuzzy set definitionand types, membership function, designing a fuzzy set for a given application. Probability andBayes'theorem,BayesianNetworks.

List of Tutorials:(Any Three)
1. HeuristicfunctiondesignforTic-Tac-Toe
2. Heuristicfunctiondesignfor8-puzzle/orgivenproblem
3. TraceofA* algorithmfor8-puzzle
4. TraceofAO*algorithmfora givenproblem
5. Conversiontoclauseform
6. Resolutioninpredicatelogic
7. Resolutioninpropositionallogic
8. Usinginferencerulesinpredicatelogic
9. Designoffuzzysetsfor agivenapplication
10. Perceptronlearningfor2classclassification

ListofPracticals: (AnySix)
1. ImplementNon-AIandAITechniques
2. ImplementanyoneTechniquefromthefollowing
a. BestFirstSearch&A*algorithm
b. AO*algorithm
c. HillClimbing
3. ImplementPerceptronlearningalgorithm
4. Implementareal-lifeapplicationinProlog.
5. ExpertSysteminProlog-newapplication
6. ImplementanytwoPlayergameusing min-maxsearchalgorithm.
7. Designafuzzysetforshapematchingofhandwrittencharacter
8. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample. Also check for classification performance metrics.

ListofProjects:(Anyprojectwithinfollowingdomain)
1. Patternrecognition–Classification,Clustering,hybrid-classificationclustering
2. Predictionusing-Regression–Linearornonlinear
3. Gameplaying-singleplayer/2-player/multi-player
4. UseofKnowledgebasedsystemforgeneratinginferences
5. DeepLearning
6. Neuralnetworktrainingand usingfor arealapplication
7. Useoffuzzysetsforhumanlikereasoning
8. UseofanyMLalgorithmforsolvingrealworldproblem
9. Anyother domainmutuallydecidedbystudentsandinstructor

List ofCourseSeminarTopics:

1. Fuzzysetstheory-Operationsonsets

2. DeepLearning

3. Non-monotonicLogicandrealapplications

4. Neuralnetworktrainingfor realapplications

5. PredicateLogicforreasoning

6. Expertsystemdesignanddevelopment

7. PROLOGandLISPcomparison

8. HeuristicSearchTechniques

9. Gameplaying- Aspecificgameandits method

10. MLAlgorithmsforpredications

11. Anyother topicsdecided and approved bytheinstructor

12. IPR in AI

13. Industry 4.0 and AI

ListofCourseGroupDiscussionTopics:

1. SemanticNetworks

2. Fuzzysetdesign for realapplication

3. Neuralnetworktrainingandtesting

4. Classification,Clusteringandhybridapproachestopatternrecognition

5. BlocksworldDomain-STRIPS

6. Predicatelogicinferencerules

7. Resolutioninpredicatelogic

8. PerceptronLearningrule

9. R-categoryperceptronlearning algorithmand applicationdesign

10. Baystheoremandclassifier

11. Anyother topicsdecidedbytheinstructor

ListofHomeAssignments:
Design:

1. Heuristicfunctiondesignforaspecificsearchapplication

2. Knowledgebasedesignforasmallexpertsystemforrealapplication

3. Designoffuzzysetsfor agivenapplication

4. DesigningNeuralnetworkarchitecturefor patternrecognition

5. Designofareasoningsystemforthe shapematching ofobjects

6. Anyothertopicmutuallydecidedbystudents-instructor

Case Study:

1. PROLOGexpertsystem

2. Alexa

3. GoogleAssistant

4. Pagerankingalgorithm

5. Emotiondetection

6. Anyothertopicmutuallydecidedbystudents-instructor

Blog

1. FutureofAI

2. DeepLearning Architectures

3. AIinhealthcare

4. AIinfinance

5. Neuralnetworkclassification

6. Anyothertopicmutuallydecidedbystudents-instructor

Surveys

1. HCRalgorithms

2. Facerecognition

3. Thumbprintrecognition

4. Imagecaptioning

5. Datasamplingtechniques

6. Anyothertopicmutuallydecidedbystudents-instructor

SuggestanassessmentScheme:

MSE   PPTPresentation   ESE   GD   Tut   Viva   Lab+CourseProject

Text Books:*(AsperIEEEformat)*

1. ElaineRichandKevinKnight:"ArtificialIntelligence."TataMcGrawHill
2. StuartRussell&PeterNorvig   :
"ArtificialIntelligence:AModernApproach",PearsonEducation,2ndEdition.

ReferenceBooks:*(AsperIEEEformat)*

1. IvanBratko:"PrologProgrammingForArtificialIntelligence",2ndEditionAddisonWesley,1440.
2. Eugene,Charniak,DrewMcdermott:"IntroductiontoArtificialIntelligence.",AddisonWesley
3. Patterson:―IntroductiontoAIandExpertSystems‖, PHI
4. Nilsson:―PrinciplesofArtificialIntelligence‖,MorganKaufmann.
5. CarlTownsend,―IntroductiontoturboProlog‖,Paperback,1483
6. JacekM.Zurada,Introductiontoartificialneuralsystems,JaicoPublication

MoocsLinksandadditionalreadingmaterial:
1. http://www.eecs.qmul.ac.uk/~mmh/AINotes/AINotes4.pdf
2. https://www.slideshare.net/JismyKJose/conceptual-dependency-701296473.https://web.archive.org/web/20150813153834/http://www.cs.berkeley.edu/~zadeh/papers/Fu zzy%20Sets-Information%20and%20Control-1965.pdf
4. https://www.youtube.com/watch?v=aircAruvnKk
5. https://www.youtube.com/watch?v=IHZwWFHWa-w
6. Otherssuggested byinstructor

CourseOutcomes:
Uponcompletionofthe course,graduateswillbe able to-
1. Understandthebasicsofthetheoryand practiceofArtificialIntelligenceasadisciplineandaboutintelligentagents capable ofproblemformulation.
2. Evaluations of different uninformed search algorithms on well formulate problemsalongwithstatingvalidconclusions thattheevaluationsupports.
3. DesignandAnalysisofinformedsearchalgorithmsonwellformulatedproblems.
4. FormulateandsolvegivenproblemusingPropositionalandFirstorderlogic.
5. Applyplanningandneural network learningfor solvingAIproblems
6. Applyreasoningfornon-monotonicAIproblems.

COattainmentlevels
CO1-2
CO2-2
CO3-3
CO4-4
CO5-5
CO6-3

FutureCoursesMapping:
FyzzyLogicand softcomputing,ArtificialNeuralnetworks,PatternRecognition,Knowledgebased systems,IntelligentSearching,NaturalLanguage Processingandetc.

JobMapping:
Knowledge Engineer in Expert system, AI Engineer, Developer -AI applications, Architect AIsolutionsandetc

AI3002: Operating System

Course Prerequisites: Basics of Computer System, Computer Organization, Data Structures and any Programming Language.

Course Objectives:

1. To understand the basic concepts and functions of Operating System.

2. To gain knowledge of process synchronization and its mechanism.

3. To get familiar with CPU scheduling algorithms.

4. To learn different deadlock handling mechanisms and memory management techniques

5. To discuss I/O management and file management

6. To understand different system software& their functionalities.

Credits: 5   **Teaching Scheme**   **Theory:** 3 Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance: This course focuses on functions of operating system. Operating system is a System software that manage the resources of the computer system and simplify applications programming. The Operating System acts as a platform of information exchange between your computer's hardware and the applications running on it.

SECTION-1
What is OS?, Interaction of OS and hardware, Basic functions of OS, OS Services, System Calls, Types of System calls, Types of OS: Batch, Multiprogramming, Time Sharing, Parallel, Distributed & Real-time OS, Process management: Process Concept, Process States: 2, 5, 7 state models, Process Description, Process Control, Multithreading models, Thread implementations – user level and kernel level threads, Concurrency: Issues with concurrency, Principles of Concurrency, Mutual Exclusion: OS/Programming Language Support: Semaphores, Mutex, Classical Process Synchronization problems, Uniprocessor Scheduling, Scheduling Algorithms: FCFS, SJF, RR, Priority.   Deadlock: Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Deadlock Recovery.

SECTION-II

Memory Management: Memory Management requirements, Memory Partitioning, Fragmentation, Paging, Segmentation, Address translation, Placement Strategies: First Fit, Best Fit, Next Fit and Worst Fit. Virtual Memory, VM with Paging, Page Table Structure, Translation Lookaside Buffer, Page Size, VM with Segmentation, Page Replacement Policies: FIFO, LRU, Optimal.

I/O management: I/O Devices - Types, Characteristics of devices, OS design issues for I/O management, I/O Buffering. Disk Scheduling: FCFS, SSTF,SCAN, C-SCAN, LOOK and C-LOOK. File Management: Concepts, File Organization, File Directories, File Sharing. Record Blocking, Secondary Storage Management

Introduction: Software types, Software hierarchy, Components of System Software, Levels ofsystem software, recent trends in software development.
Language processors: Programming languages and language processors, fundamentals of language processing,life cycle of a source program, language processing activities, data structures forLanguage processing: search data structures, allocation data structures.

List of Tutorials: (Any Three)

1) Linux Commands

2) Linux File Hierarchy Structure/ Filesystem Hierarchy Standard

3) OS Structures

4) File System in Windows and Linux

5) CPU scheduling algorithms

6) Deadlock avoidance algorithm

7) Memory management techniques

8) Memory management techniques

9) Disk scheduling algorithms

10) Free space management

List of Practicals: (Any Six)

1) Execution of Basic Linux commands.
2) Execution of Advanced Linux commands.
3) Any shell scripting program.

4) Write a program demonstrating use of different system calls.
5) Implement multithreading for Matrix Operations using Pthreads.
6) Implementation of Classical problems using Threads and Mutex /Semaphore
7) Write a program to compute the finish time, turnaround time and waiting time for the following algorithms:
    a) First come First serve b) Shortest Job First (Preemptive and Non Preemptive)
    c) Priority (Preemptive and Non Preemptive) d) Round robin
8) Write a program to check whether given system is in safe state or not using Banker's Deadlock Avoidance algorithm.
9) Write a program for following placement algorithm check whether memory can be allocated to given process or not by using following methods
    a) First fit   b) Best fit   c) Worst fit   d) Next fit
10) Write a program to calculate the number of page faults for a reference string for the following page replacement algorithms:
    a) FIFO   b) LRU   c) Optimal
11) Write a program to implement the following disk scheduling algorithms:
    a) FCFS   b) SCAN   c) C-SCAN   d) SSTF

List of Projects:

1. Design and implementation of a Multiprogramming Operating System: Stage I

   i.CPU/ Machine Simulation

   ii.Supervisor Call through interrupt

2. Design and implementation of a Multiprogramming Operating System: Stage II

   i. Paging

   ii. Error Handling

   iii. Interrupt Generation and Servicing

   iv. Process Data Structure

3. Design and implementation of a Multiprogramming Operating System: Stage III

i. Multiprogramming

   ii. Virtual Memory

   iii. Process Scheduling and Synchronization

   iv. Inter-Process Communication

   v. I/O Handling, Spooling and Buffering

List of Course Seminar Topics:

1. Different File Systems in Windows and Linux OS

2. Operating System generations

3. OS Structures

4. System call Vs API

4. Classical process synchronization problems

5. Process Vs Threads

6. Virtual Machines

7. Real Time Scheduling

8. Booting Process of different Operating Systems.

9.Interprocess Communication (IPC)

10. Deadlock Handling mechanisms

List of Course Group Discussion Topics:

1. Flynn's taxonomy

2. Role of Operating system

3. 32 bit Vs 64 bit OS

4. Storage structures and their tradeoffs

5. Disk Scheduling

6. Desktop OS Vs Mobile OS

7. Security Vs Protection in OS

8. I/O processors

9. Linux Vs Windows OS

10. Best OS for smartphones

List of Home Assignments:

Design:

1. Report Generation using Shell Script an AWK

2. Library Management System using shell

3. Inter Process Communication in Linux

4. Design any real time application using job scheduling

5. Design any application using Android

Case Study:

1. Distributed Operating System

2. Microsoft Windows 10

3. VMware

4. Linux

5. Android

Blog

1. Operating System Forensics

2. Open Source OS Vs Commercial OS

3. BIOS

4. Comparative study of different mobile OS

5. Operating Systems for IoT Devices

Surveys

1. A survey of Desktop OS

2. Analysis and Comparison of CPU Scheduling Algorithms

3. Device Drivers for various devices

4. Parallel Computing

5. Malware Analysis, Tools and Techniques

Suggest an assessment Scheme:

1. Home Assignment: Design, Case Study, Blog and Survey

2. MCQ

3. CVV

4. Seminar

5. Group Discussion

6. LAB-Course Assignment and Project Evaluation

Text Books: (As per IEEE format)

1. Stalling William;"Operating Systems"; 6thEdition,Pearson Education;

2. Silberschatz A., Galvin P., Gagne G.;"Operating System Concepts" ; 9th Edition; John Wiley and Sons;

3. YashavantKanetkar; "Unix Shell Programming"; 2nd Edition, BPB Publications

4. Sumitabha Das; "Unix Concepts and Applications"; 4th Edition, TMH.

5. D M Dhamdhere; "Systems Programming & Operating Systems"; Tata McGraw HillPublications, ISBN – 0074635794

6. John J Donovan; "Systems Programming"; Tata Mc-Graw Hill edition , ISBN-13978-0-07-460482-3

Reference Books: (As per IEEE format)

1. Silberschatz A., Galvin P., Gagne G; "Operating System Principles"; 7th Edition, John

Wiley andSons.

2. Forouzan B. A., Gilberg R. F.; "Unix And Shell Programming"; 1st Edition, Australia

Thomson Brooks Cole.

3. Achyut S. Godbole , Atul Kahate; "Operating Systems"; 3rd Edition, McGraw Hill.

Moocs Links and additional reading material:

1. www.nptelvideos.in

2. https://www.udemy.com/

3. https://learn.saylor.org/

4. https://www.coursera.org/

5. https://swayam.gov.in/

Course Outcomes:

The student will be able to –

1) Examine the functions of a contemporary Operating system with respect to convenience, efficiency and the ability to evolve.

2) Demonstrate knowledge in applying system software and tools available in modern operating system for process synchronization mechanisms.

3) Apply various CPU scheduling algorithms to construct solutions to real world problems and identify the mechanisms to deal with Deadlock.

4) Illustrate the organization of memory and memory management techniques

5) Analyze I/O and file management techniques for better utilization of secondary memory

6) Discriminate among different System software and their functionalities.

CO PO Map:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		2														
CO 2			2													
CO 3					3											
CO 4						2										
CO 5										1						
CO 6														3		

CO attainment levels:

CO1-1

CO2-2

CO3-4

CO4-5

CO5-3

CO6-2

Future Courses Mapping: Advance Operating System, Unix Operating System,Linux programming, Distributed System/Computing, High Performances Computing, System Programming

Job Mapping: Linux Administration, Kernel Developers, Application Developers, System programmer,System architect

AI3003: STATISTICAL INFERENCE

CoursePrerequisites: BasicknowledgeofStatisticsandProbability, Python

CourseObjectives:

1. Getbasicunderstandingaboutstatisticalmodelsandtheiruse.
2. Applylinear and regressionmodelsdependingupontheproblemcontext.
3. Getabetterunderstandingofprobabilisticmodels.
4. Derive inferencefromdifferentstatisticaldatasets.

Credits: 5   **TeachingSchemeTheory: 3**Hours/Week

                                           Tut:1 Hours/Week

                                           Lab:**2**Hours/Week

CourseRelevance: Machine learning,DataScience

SECTION-I
Topicsand Contents   Introduction, Basic concepts from statistics, definition and uses of models, how models areused in practice, key steps in the modeling process. Linear models and optimization, leastsquareestimation,linear discriminantanalysis,Quadratic Discriminant Analysis, Factor analysis, principal component analysis, Concept of Outliers   **Correlation, Regression and Generalization:**Correlation and its type, Regression: Linear Regression, logisticregression, Assessing performance of Regression – Errormeasures,OverfittingandUnderfitting,CatalystsforOverfitting,VCDimensionsLinearMode ls:LeastSquaremethod,UnivariateRegression,MultivariateLinearRegression,Regularized   Regression - Ridge Regression and Lasso Theory of Generalization: Bias andVarianceDilemma, Training and Testing CurvesCaseStudyof Polynomial CurveFitting, Analysis ofvariance model, interpretation of regression coefficients, fittingcurvesto data,multipleregression,Poissonregression, Modeling non-linearrelationships, Heteroscedasticity,Multicollinearity and Autocorrelation.

SECTION-II

Topicsand Contents

Introduction to probabilistic models, some examples of probabilistic models, noisy channelmodel,sourcechannelmodel,jointsourcechannelmodels,Monte-CarloSimulations,Building blocks ofprobability models, various distributions (Bernoulli, Binomial, Normaldistribution),mixturemodels,bootstrapmaximumlikelihoodmethods,Bayesianmethod,expectation maximization, Markov-chain models, Hidden Markov model, Conditional randomfields, Latent variable probabilitymodels

ListofTutorials:(AnyThree)

1. Considerthe followingset ofpoints:{(-2,-1),(1,1),(3,2)}

    a. Findtheleastsquareregressionline forthegivendatapoints.

    b. Plotthegivenpointsand theregressionlineinthesamerectangular systemofaxes.

2. FindtheStandardDeviation,Variance,Mean,Median,Modeforthefollowingdata7,11,11,15,20,20,28.

3. A2-Ddatasetisgivenbelow.

4. C1=X1={(4,1),(2,4),(2,3),(3,6),(4,4)}

5. C2=X2={(9,10),(6,8),(9,5),(8,7),(10,8)}

6. Calculatethedimensionalityreductionusing lineardiscriminantanalysis.

1. Find the coefficient of Regression for the following

dataX12   3   4   5   6   7   8   9

Y9   8   10   12   11   13   14   16   15

2. Findwhether Null-Hypothesis iscorrectornotusingOne-WayANNOVAAB

   C

23	4
45	6
67	8

6.   SolvePoissonRegressionmodelproblemusingaworkableexample.

7. FindthePrincipalComponentsforZ1,Z2forthefollowingmatrixA^T=

| 2 | 1 | 0 | -1 |
| 4 | 3 | 1 | 0.5 |

8. ADieisthrown6-times.Ifgetting anoddnumberisa successwhatisthe probabilityof

i. 5-Success
ii.   Atleast5-Success
iii. Atmost5-Success

9. Ifafaircoin istossed10timesthen find theprobabilityof
i. Exactly6heads
ii. Atleast6heads
iii. Atmost6heads

10. In a boltfactory, Machines A, B and C manufacture respectively 25%, 35% and 40% ofthe
    total bolts. Out of their total output 5, 4 and 2 percentage are respectively defectivebolts. A
    bolt is drawn at random from the product. If the bolt is defective, what is theprobabilitythatthe
    boltismanufacturedbyMachineB.

ListofPracticals: (AnySix)
  1.   Leastsquareestimate
  2.   Linearregression
  3.   Logisticregression
  4.   Factoranalysis
  5.   Principalcomponent analysis
  6.   Noisychannel model
  7.   Sourcechannelmodel
  8.   Maximumlikelihoodmethod
  9.   Expectationmaximization
  10. Markovchains
  11. HiddenMarkov model

ListofProjects:
1. ImplementlinearregressiontopredicthousingpriceusingtheHousingdatasetofBoston.
2. ImplementLogisticregressiontodocreditscorepredictionusingGermancredits scoredataset.
3. ImplementfactoranalysistofindtheimportantfeaturesoutofallfeaturespresentintheStudentPerformanceDataset.
4. ImplementPrincipal   Componentanalysistoidentifythecrucialfeaturesout ofallfeaturespresentinthe Breastcancerdataset.
5. ImplementLogisticregressionmodelforthepredictionofLungcancerdiseaseusingUCILungcancerdataset.
6. Compare Average Global Temperatures and Levels of Pollution (linear regression)
7. Compare Budgets of National Film Awards-nominated Movies with the number Movies Winning These Awards (linear regression)
8. Implement different feature selection techniques on any data set.

ListofCourseSeminarTopics:
1. Leastsquareestimation
2. Lineardiscriminantanalysis
3. LinearRegression
4. LogisticRegression
5. Anova
6. Ancova
7. Rootmeansquareerror
8. PoissonRegression
9. PrincipalComponent analysis
10. Entropy estimation
11. Biased sample
12. Kappa statistics

ListofCourseGroupDiscussionTopics:
1. Noisychannel model
2. Sourcechannelmodel
3. Montecarlosimulation
4. BinomialDistribution
5. NormalDistribution
6. Markovchainmodel
7. Bootstrapmaximumlikelihoodmethods
8. BayesianMethod
9. Performance Evaluation Metrics for Regression problems
10. Measures of central tendency vs measures of variability
11. Avoidingoverfittingandunderfittinginclassifiers

ListofHomeAssignments:
Design:
1. Heart diseaseprediction
2. CustomerReviewclassification
3. Sensorlessdrivediagnosis
4. Defaultcreditcardclientclassification
5. Devnagrihandwrittencharacterclassification

Case Study:
1. Classificationmodels
2. Regressionmodels
3. Maximumlikelihood
4. Generalizedlineardiscriminantanalysis.
5. ConditionalRandomfields

Blog
1. Logisticregression
2. Support vectormachine
3. Typesoferror
4. Markovchainmodel
5. Latentvariableprobabilitymodel

Surveys
1. Randomforestvs Decisiontree
2. PrincipalComponent analysis
3. Bayesianmethod
4. Typesofdistribution
5. Differentvariancemodels

Text Books:*(AsperIEEEformat)*

1.The Elements of Statistical Learning: Data Mining, Inference, and Prediction. By TrevorHastie, Robert Tibshirani, Jerome Friedman, Hardcover: 745 pages, Publisher: Springer; 2nded.2009,ISBN-10:0387848576

2. StatisticalModelsbyA.C.Davison-
Paperback:738pages,Publisher:CambridgeUniversityPress;1edition(30June2008)ISBN-10:0521734495CambridgeUniversityPress

ReferenceBooks:*(AsperIEEEformat)*

1. S.C.Gupta;"FundamentalsofStatistics7thEdition";   HimalayaPublishingHousePvt.Ltd.
2. AbdulHamidKhan,MANOJKUMARSRIVASTAVA,andNAMITASRIVASTAVA;"STATISTICALINFE RENCE:THEORYOFESTIMATION";PhiLearning

MOOCsLinksandadditionalreadingmaterial:
1. Statisticstutorial-https://www.youtube.com/channel/UCQKwruq0LY3cjvSx7_M5JAg
2. Inferential Statistics- https://www.youtube.com/watch?v=-FtlH4svqx4&list=PLSQl0a2vh4HDl0hgK8nIBgBjLji5Eu9ar

CourseOutcomes:
1. Understandbasicsaboutstatisticalmodelsandhowthemodelsareusedinpractice
2. Understandbasicconceptsoflinearmodelsandregression
3. Understandbasicsofprobabilisticmodels,Markovmodels,Markovprocesses
4. Understandbasicsoftreebasedmodels
5. Determinesuitable statisticalmodels forthepracticalproblems.
6. Applysuitablemodeltothepracticaldataandderivethestatisticalinferences

FutureCoursesMapping:
Machinelearning,DeepLearning

JobMapping:

For all jobs in the domain of AI&DS knowledge of statistical inference is prerequisite. To name a few Big Data Engineer, Business Intelligence Developer, Data Scientist, Machine Learning Engineer, Research Scientist, AI Data Analyst, Product Manager, AI Engineer, Robotics Scientist, Machine Learning Architect etc.

AI3004: Cloud computing

Course Prerequisites: Nil
Course Objectives:
 1. Understand the architecture and infrastructure of cloud.
2. Learn the resource virtualization technique.
3. Build the appropriate file system and database.
4. Design a algorithm for a given business case using Map-Reduce model
5. Develop a SaaS solution for a real world problem with collaborative efforts
Course Relevance:
This course is widely applicable in software and manufacturing industries for storage purpose.

SECTION-1
Topics and Contents
Introduction to Cloud Computing, Definition, Characteristics, Components, Cloud Service Models: SaaS, PaaS, IaaS, Cloud provider, benefits and limitations, Deploy application over cloud, Cloud computing vs. Cluster computing vs. Grid computing. Open Stack vs Cloud Stack, Role of Open Standards,Infrastructure as a Service (IaaS): Virtualization Technology: Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine (VM). Virtualization: Server, Storage, Network. Virtual Machine (resource) provisioning and manageability, storage as a service, Data storage in cloud computing(storage as a service),Multitenant software: Multi-entity support, Multi-schema approach, Multitenance using cloud data stores, Data access control for enterprise applications,Cloud file-systems: GFS and HDFS, BigTable, Features and comparisons among GFS, HDFS etc.,Databases on Cloud: NoSQL, MogoDB, HBase, Hive, Dynamo, Graph databases

SECTION-II
Topics and Contents
Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Example/Application of Mapreduce, PaaS: Introduction to PaaS - What is PaaS, Service Oriented Architecture (SOA). Cloud Platform and Management - computation, storage SaaS: Introduction to SaaS, Web services, Web 2.0, Web OS, Case Study on SaaS Service Management in Cloud Computing: Service Level Agreements(SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting enormously, Managing Data - Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing Cloud Security: Infrastructure Security - Network level security, Host level security, Application level security. Data security and Storage - Data privacy and security Issues, Jurisdictional issues raised by Data location: Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations.

List of Practicals (Any 6):

1. Installation and configuration of own Cloud
2. Study and implementation of infrastructure as Service using OpenStack
3. Installing two Virtual Machines on VirtualBox and let them communicate with each other
4. Implementation and case study of Google App Engine.
5. Implementation and case study of Saleforce.com cloud
6. Study and Implementation of any one cloud file system
7. Study and implementation of MongoDB cloud database
8. Implementation of Map-Reduce model
9. Case study on any one Cloud Monitoring tool
10. Case study on any one Cloud Security tool

List of Course Seminar Topics:(any 6)
1. IaaS model for cloud
2. PaaS for cloud
3. SaaS application and host it on Cloud Platform
4. Repository in Cloud
5. Amazon Virtual Private Cloud (Amazon VPC)
6. ML task in cloud
7. AI task in Cloud
8. Deploy and manage cloud environment
9. Authentication in cloud 10. Service Oriented Architecture (SOA)

List of Course Group Discussion Topics:(any 6)
1. Cloud Service Models
2. Cloud computing vs. Cluster computing vs. Grid computing
3. Virtualization
4. Cloud file-systems
5. Cloud data stores
6. Databases on Cloud
7. Map-Reduce model for Cloud
8. Data security and Storage for Cloud
9. Application security for Cloud
10. Commercial and business risk and opportunities in Cloud

List of Home Assignments:
Design:
1. Design Local Train ticketing system using Cloud
2. Design online Book-store system using Cloud
3. Cloud based Attendance system
4. University campus online automation using Cloud
5. Cloud based student information chatbot

Case Study:
1. Secure file storage in Cloud
2. Android offline computations over Cloud
3. Data leak detection in E-commerce cloud applications.
4. e-Bug tracking in Cloud

5. Rural Banking using Cloud

Blog
1. Private Vs Public Cloud
2. Storage and Energy efficient Cloud computing
3. CIO-Cloud
4. Cloud computing Intelligence
5. High scalability in Cloud

Surveys:
1. Public cloud security
2. Cloud based Improved file handling
3. E-learning platform using cloud computing
4. DevOps and Cloud
5. Cloud service providers(CSP)

Suggest an assessment Scheme:
1. Home Assignment
2. MCQ
3. Quiz
4. Seminar
5. Group Discussion
 6. Viva

Text Books: (As per IEEE format)
1. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, "Cloud Computing for Dummies", Wiley India.
2. Ronald Krutz and Russell Dean Vines, "Cloud Security", Wiley-India

Reference Books: (As per IEEE format)
1. Barrie Sosinsky, "Cloud Computing Bible", Wiley India
2. Antohy T Velte, et.al, "Cloud Computing : A Practical Approach", McGraw Hill.
3. McGraw Hill, "Cloud Computing", Que Publishing.

Moocs Links and additional reading material:
www.nptelvideos.in

Course Outcomes:
The student will be able to –
1. Illustrate the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
2. Investigate the resource virtualization technique for a given business case
3. Choose the appropriate file system and database for a given business case
4. Develop a algorithm for a given business case using Map-Reduce model
5. Build a SaaS solution for a real world problem with collaborative efforts
6. Identify the challenges in Cloud Management and Cloud Security

CO attainment levels
 CO1-3, CO2- 3, CO3-4, CO4-4, CO5-5, CO6-5

Future Courses Mapping:

Mobile application development, Advance web technology

Job Mapping:

Cloud Architect, cloud developer, web developer

HONOUR: Machine Learning

CoursePrerequisites: LinearmAlgebraandCalculus,ProbabilityBasics

CourseObjectives:

1. UnderstandingHumanlearningaspects.
2. Acquaintancewithprimitivesinthelearningprocessbycomputer.
3. Understandingthenatureofproblemssolvedwith MachineLearning.
4. Tostudydifferentsupervised learningalgorithms.
5. Tostudydifferentunsupervisedlearningalgorithms.
6. TounderstandtheapplicationdevelopmentprocessusingML.

Credits:5   **TeachingSchemeTheory:3**Hours/Week

Tut: 1Hours/Week

Lab: **2Hours**/Week

CourseRelevance: DataScience, ArtificialIntelligence

SECTION-I
Topicsand Contents   **Introduction:**WhatisMachineLearning,ExamplesofMachineLearningapplications,TrainingversusTesting,Positive andNegative Class,Cross-validation.   **Types of Learning**: Supervised, Unsupervised and Semi-Supervised Learning. DimensionalityReduction:IntroductiontoDimensionalityReduction,SubsetSelection.   **ConceptLearning:**ConceptLearning,General-to-SpecificOrdering:Task,search,FindS   algorithm, Version space and the candidate elimination algorithm, List-then-   eliminatealgorithm,inductive bias.

Classification: Binary   and   Multiclass   Classification:Assessing   Classification Performance,Handling more than two classes, Multiclass Classification-One vs One, One vs Rest LinearModels: Perceptron, Support Vector Machines (SVM), Soft Margin SVM, Kernel methods fornon-linearity

Clustering:

Basicconceptsandalgorithms,c-meansclustering,typesofclustering,evaluationofclustering,confusionmatrix

SECTION-II

Topicsand Contents

LogicBasedandAlgebriacModels: DistanceBasedModels:NeighborsandExamples,Nearest Neighbor Classification, Distance based clusteringalgorithms- K-means and K-medoids, Hierarchical clustering. Rule Based Models: Rule learning for subgroup discovery,TreeBased Models: Decision Trees, Random Forest, Minority Class, Impurity Measures – Gini Index and Entropy,BestSplit.

ProbabilisticModels: ConditionalProbability,JointProbability,ProbabilityDensityFunction,Nor malDistributionanditsGeometricInterpretation,NaïveBayesClassifier,DiscriminativeLearningwi thMaximumLikelihood.ProbabilisticModelswithHiddenvariables:Expectation-Maximizationmethods,GaussianMixtures

TrendsinMachineLearning: EnsembleLearning:CombiningMultipleModels,Bagging,Random ization,Boosting,Stacking,ReinforcementLearning:Exploration,Exploitation,Rewards, Penalties,reinforcementlearning.

Machine Learning with Large Datasets => scalable learning techniques, such as streamingmachinelearningtechniques;parallelinfrastructuressuchasmap-reduce;practicaltechniquesforreducingthememoryrequirementsforlearningmethods,suchasfeatu rehashing and Bloom filters; and techniques for analysis of programs in terms of memory, diskusage,and(for parallelmethods)communicationcomplexity.

ListofTutorials:(AnyThree)
1. FeatureSelectionTechniques
2. SupervisedLearning
3. UnsupervisedLearning
4. ReinforcementLearning
5. Collaborativefiltering
6. QLearning
7. ItembasedRecommendersystem
8. Realtimeapplications

ListofPracticals: (AnySix)
1. Normalization
2. Detection
3. Optimization
4. Classification
5. Clustering
6. Collaborativefiltering
7. Recommendersystems
8. SupportVectormachines
9. Decisiontreeand randomforestmodel

ListofProjects:
1. chatbot
2. stockmarketprediction
3. sentimentanalysis
4. IrisFlowersClassificationProject.
5. HousingPricesPredictionProject.
6. MNISTDigitClassificationProject.
7. StockPricePredictionusingMachineLearning.
8. FakeNewsDetectionProject.
9. BitcoinPricePredictorProject.
10. UberDataAnalysisProject.
11. CreditCardFraudDetectionProject.
12. Customer Churn Prediction
13. Campaign effectiveness prediction
14. Future business prediction
15. Kidney failure using UCI Chronic kidney disease data set.
16. Classify Parkinson diseaseusing the parikson dataset present in UCI repository.
17. Classify Thyroid disease using the Thyroid dataset present in UCI repository.
18. Predict thesafetylevelofacarusing theCarevaluationdatasetpresentinUCIrepository.
19. PredicttheconsequencesofHorseusingHorsecolic datasetpresentinUCIrepository.

List ofCourseSeminarTopics:
1. NaiveBayes Algorithm
2. MachineAndPrivacy
3. LimitationsofML
4. EnsembleLearning
5. Dimensionalityreductionalgorithms
6. ComparisonofMachineLearningalgorithms
7. FeatureExtractioninMachineLearning
8. ReinforcementLearning
9. ProbabilisticModel
10. Cross Validation Techniques
11. Imbalanced classification problems
12. Techniquesofclusteranalysis
13. Fastclusteringtechniques
14. Neuralnetworkclassifiers
15. SVMclassifier

ListofCourseGroupDiscussionTopics:
1. SupervisedVsUnsupervised
2. UnivariateVsMultivariateanalysis
3. Accuracymeasuring methods
4. BiasVsVarianceTradeoff
5. DataReductionVsDimensionalityreduction
6. ContinuousVsDiscretevariables
7. Performance Evaluation Metrics for Classification problems
8. Precision & Recall tradeoff
9. Resampling techniques comparison

ListofHomeAssignments:

Design:

Propensity to Foreclose:Predicting propensity of the customer to foreclose their loans. Theobjectiveistoretainthe customerforthemaximumtenure.

Portfolio & Price Prediction for Intra-day trades:Price movement prediction using a maskedset of features - This involves predicting short-term to mid-term price movements using acombinationofmultiplefeatures.

Smart BuildingEnergyManagementSystemusingMachineLearning

Quickanalysisofqualityofcereals,oilseedsand pulsesusingML

Video LibraryManagementSystemusingMachineLearning

Case Study:

Product Recommendation: Given a purchase history for a customer and a large inventory ofproducts,identify thoseproducts in whichthatcustomerwillbeinterestedandlikely topurchase. A model of this decision process would allow a program to make recommendationsto a customer and motivate product purchases. Amazon has this capability. Also think ofFacebook, GooglePlus and LinkedIn that recommend users to connect with you after you sign-up.

MedicalDiagnosis:Giventhesymptomsexhibitedinapatientandadatabaseofanonymized   patient records, predict whether the patient is likely to have an illness. A model ofthis decision problem could be used by a program to provide decision support to medicalprofessionals.

Stock Trading: Given the current and past price movements for a stock, determine whetherthe stock should be bought, held or sold. A model of this decision problem could providedecisionsupporttofinancialanalysts.

Customer Segmentation: Given the pattern of behaviour by a user during a trial period and the past behaviors of all users, identify those users that will convert to the paid version of the product and those that will not. A model of this decision problem would allow a program to trigger customer interventions to persuade the customer to covert early or better engage in the trial.

Shape Detection: Given a user hand drawing a shape on a touch screen and a database of known shapes, determine which shape the user was trying to draw. A model of this decision would allow a program to show the platonic version of that shape the user drew to make crisp diagrams. The Instaviz iPhone app does this.

Blog

1. FocusingTooMuchonAlgorithmsandTheories.
2. Mastering ALLofML.
3. HavingAlgorithmsBecomeObsmgoleteasSoonasDataGrows.
4. GettingBadPredictionstoComeTogetherWithBiases.
5. MakingtheWrongAssumptions.
6. ReceivingBadRecommendations.
7. HavingBadDataConverttoBadResults.

Surveys

1. Conceptlearning
2. reinforcement learning
3. semisupervised learning
4. deep learning
5. transferlearning

SuggestanassessmentScheme:
MSE   PPTPresentation   ESE   GD   Tut   Viva   Labassigts.+CourseProject

Text Books:*(AsperIEEEformat)*
1. T.Mitchell,"MachineLearning",McGraw-Hill,1997. *2. AnupKumarSrivastava, SoftComputing,AlphaScienceInternationallimited.2009.*

ReferenceBooks:*(AsperIEEEformat)*
1. EthemAlpaydin, "IntroductiontoMachineLearning", MITpress, 2004. *2. JacekM.Zurada,"IntroductiontoArtificialneuralSystem",JAICOpublishinghouse,2002,.*

MoocsLinksandadditionalreadingmaterial: www.nptelvideos.in

CourseOutcomes:
1. Demonstrate   knowledge of learning algorithms and concept learning throughimplementationforsustainablesolutionsofapplications. 2. Evaluatedecisiontreelearningalgorithms. 3. Analyzeresearch-basedproblemsusingMachinelearningtechniques. 4. Applydifferentclusteringalgorithmsused   inmachine learningtogenericdatasetsandSpecificmultidisciplinarydomains. 5. FormulateagivenproblemwithintheBayesianlearningframeworkwithfocusonBuildinglifelonglearningability. 6. EvaluationofdifferentalgorithmsonwellformulatedproblemsalongwithstatingValid conclusions thattheevaluationsupports.

COattainmentlevels CO1-2 CO2-2 CO3- 4 CO4-4 CO5-5 CO6-5

FutureCoursesMapping: *MSinMachine Learning*

JobMapping: *All industries in AI&DS always look for strong knowledge of Machine Learning for various job positions like Big Data Engineer, Business Intelligence Developer, Data Scientist, Machine Learning Engineer, Research Scientist, AI Data Analyst, Product Manager, AI Engineer, Robotics Scientist, Machine Learning Architect.*

FF No. : 654

AI3010: COMPLEXITY & ALGORITHMS

CoursePrerequisites: Basiccourseonprogramming, Datastructures,Discretestructures

CourseObjectives:

1. Formulateagiven computationalprobleminanabstractandmathematicallyprecisemanner.
2. Chooseasuitableparadigmtodesignalgorithms forgivencomputationalproblems.
3. Understandasymptoticnotationsand applysuitablemathematicaltechniquesto findasymptotic timeandspace complexities ofalgorithms.
4. UnderstandnotionsofNP-hardnessandNP-completenessandtheirrelationshipwiththeintractabilityofdecisionproblems.
5. Applyrandomized, approximationalgorithms forgivencomputationalproblems.

    Credits:5   **TeachingSchemeTheory:3**Hours/Week

                                              Tut:1 Hours/Week

                                              Lab:**2**Hours/Week

Course Relevance: This is an important course for AI-DS Engineering. It develops algorithmicthinking capability of students. Designing algorithms using suitable paradigms and analyzing thealgorithms for computational problems has a high relevance in all domains of IT (equally inIndustry as well as research). Once the studentgains expertise inAlgorithm design andingeneral gains the ability of Algorithmic thinking, it facilitates in systematic study of any otherdomain (in IT or otherwise) which demands logical thinking. This course is also relevant forstudents who want to pursue research careers in theory of computing, computational complexitytheory,advancedalgorithmicresearch.

SECTION-I

Basicintroduction to timeandspacecomplexityanalysis:

Asymptotic notations (Big Oh, small oh, Big Omega,Theta notations). Best case,averagecase, and worst-case time and space complexity of algorithms. Overview of searching, sortingalgorithms. Adversary lower bounds (for the comparison-based sorting algorithms, for findingsecond minima). Using Recurrence relations and Mathematical Induction to get asymptoticboundsontimecomplexity.Master'stheoremandapplications.Provingcorrectnessofalg orithms.

Divide and Conquer: General strategy**,** Binary search and applications, Analyzing Quick sort,Merge sort, Counting Inversions,Finding a majority element, Order statistics (randomizedand deterministic algorithms), Josephus problem using recurrence, Efficient algorithms forInteger arithmetic (Euclid's algorithm, Karatsuba's algorithm for integer multiplication, fastexponentiation).

Dynamic Programming: General strategy, simple dynamic programming based algorithms tocompute Fibonacci numbers, binomial coefficients,Matrix Chain multiplication, Optimalbinary search tree (OBST) construction,Coin change problem, 0-1 Knapsack, TravelingSalespersonProblem,Allpairshortestpathalgorithm,Longestincreasingsubsequencepro blem,Largestindependentsetfortrees.

SECTION-II

Greedy strategy: General strategy, Analysis and correctness proof of minimum spanning treeand shortest path algorithms, fractional knapsack problem, Huffman coding, conflict freescheduling.

Backtracking strategy: General strategy, n-queen problem, backtracking strategy for someNP-complete problems(e.g.graphcoloring,subsetsum problem,SUDOKU)

BranchandBoundstrategy:LIFOSearchandFIFOsearch, Assignmentproblem

IntroductiontocomplexityclassesandNP-completeness:

Complexity classes P, NP, coNP, and their interrelation, Notion of polynomial time many onereductions reduction, Notion of NP-hardness and NP-completeness, Cook-Levin theorem andimplication to P versus NP question, NP-hardness of halting problem. NP-Complete problems(someselected examples),reducingNPproblemstoIntegerLinearProgramming.

 IntroductiontoRandomizedandApproximationalgorithms:

Introductiontorandomnessincomputation,Las-VegasandMonte-Carloalgorithms,

Abundance of witnesses/solutions and application of randomization, solving SAT for formulaswith "many" satisfying assignments, randomized quick sort, majority search, Karger's Min-cut algorithm, coupon collector problem, randomized data structures (randomized BST, skiplists)

Introduction to Approximation algorithms for NP-optimization problems, Vertex Cover, metricTraveling-Sales-Person Problem (metric-TSP),HardnessofapproximationforTSP.

ListofTutorials:(AnyThree)
1. Complexityanalysisbasedonasymptoticnotations, solutionofrecurrences**.**
2. ComplexityanalysisbasedonDivideandConquerstrategy.
3. ComplexityanalysisbasedonDivideandConquerstrategy.
4. Complexityanalysis basedonDynamicProgrammingstrategy.
5. Complexityanalysis basedonDynamicProgrammingstrategy.
6. Complexityanalysisbased onGreedystrategy.
7. Complexityanalysis basedonBacktrackingstrategy.
8. Provingcorrectnessofalgorithms: sometechniques.
9. Adversarylowerboundtechnique.
10. Problemsolvingbasedoncomplexityclasses, NP-completeness

ListofPractical:(AnySix)

1. Assignmentbasedonsomesimplecodingproblemsonnumbers, graphs,matrices.
2. Assignmentbasedonanalysisofquicksort(deterministicandrandomizedvariant).
3. AssignmentbasedonDivideandConquer strategy(e.g.majorityelementsearch,findingkthrankelementinanarray).
4. Assignmentbased on Divide and Conquer strategy (e.g.efficientalgorithm for Josephusproblemusingrecurrence relations,fastmodularexponentiation).
5. Assignmentbased on Dynamic Programmingstrategy (e.g.Matrix chainmultiplication, Longest increasing subsequence).
6. AssignmentbasedonDynamicProgrammingstrategy(eg,Allpairshortestpath,TravelingSales Personproblem).
7. AssignmentbasedonGreedystrategy (e.g.Huffmanencoding).
8. AssignmentbasedonBacktracking (e.g.graphcoloring, n-queenproblem).
9. AssignmentbasedonLas-VegasandMonte-Carloalgorithmformajorityelementsearch.
10. Assignmentbasedonfactor-2approximationalgorithmformetric-TSP.

ListofProjects:
1. ApplicationsofA*algorithm ingaming.
2. Pac-Mangame.
3. Creation /Solution of Maze (comparingthebacktracking-basedsolutionandDijkstra'salgorithm).
4. Different exact andapproximationalgorithmsforTravelling-Sales-PersonProblem.
5. Knighttouralgorithms.
6. Networkflow optimization andmaximummatching.
7. AIfordifferentgamessuchas minesweeper,shootinggames,Hex, connect-4,sokoban, etc.
8. SUDOKUsolver.
9. Algorithmsforfactoring large integers.
10. Randomizedalgorithmsforprimalitytesting(Miller-Rabin,Solovay-Strassen).

List ofCourseSeminarTopics:
1. Complexityclasses
2. Spacecomplexity
3. DivideandConquerVsDynamicProgramming
4. GreedystrategyVsBacktrackingstrategy
5. DynamicProgramming VsGreedy
6. ComputationalComplexity
7. ComparisonofPVsNP problems
8. CompressionTechniques
9. Approximationalgorithms
10. Pseudorandomnumbergenerators

ListofCourseGroupDiscussionTopics:
1. GreedyAlgorithmsVs.DynamicProgrammingstrategy
2. DynamicProgramming VsGreedy
3. NP-completeness
4. PVsNPproblems
5. Paradigms for algorithmdesign
6. DifferentSearchingtechniques
7. RelevanceofCook-Levintheorem
8. Randomnessincomputation
9. ApproximationAlgorithms
10. ApplicationofRecursion

ListofHomeAssignments:
Design:
1. Divideand Conquer strategy for realworld problemsolving
2. DynamicProgrammingstrategyfor realworldproblemsolving
3. ProblemsonRandomizedAlgorithms
4. ProblemsonApproximationAlgorithms
5. ProblemsonNPcompleteness

Case Study:
1. Encodingtechniques
2. Networkflowoptimizationalgorithms
3. Approximationalgorithms forTSP
4. Sortingtechniques
5. AKSprimalitytest

Blog
1. HowtodecidesuitabilityofApproximationAlgorithms
2. WhendoRandomizedAlgorithmsperformbest
3. ApplicationsofComputationalGeometryAlgorithms
4. Roleofnumber-theoreticalgorithms incryptography
5. PerformanceanalysisofGraphTheoreticAlgorithms

Surveys
1. PrimalityTestingAlgorithms
2. IntegerFactoringAlgorithms
3. ShortestPathAlgorithms
4. AlgorithmsforfindingMinimumWeightSpanningTree
5. SATsolvers

SuggestanassessmentScheme:
Suggesta   anAssessmentscheme
thatisbestsuitedforthecourse.Ensure360degreeassessmentandcheckifitcovers
allaspectsofBloomsTaxonomy.

MSE   ESE   Tutorial   Lab   HA   Seminar   GD

Text Books:(AsperIEEEformat)

1. Cormen,Leiserson,RivestandStein"IntroductiontoAlgorithms",3ᵈᵈedition,2009.ISBN81-203-2141-3,PHI

2. JonKleinberg,EvaTardos"AlgorithmDesign",1ˢᵗedition,2005.ISBN978-81-317-0310-6,Pearson

3. *Dasgupta,Papadimitriu,Vazirani"Algorithms",1edition(September13,2006),ISBN-10:9780073523408,ISBN-13:978-0073523408,McGraw-HillEducation*

ReferenceBooks:(AsperIEEEformat)

1. Motwani,Raghavan"RandomizedAlgorithms",CambridgeUniversityPress;1edition(August25,1995),ISBN-10:0521474655,ISBN-13:978-0521474658

2. Vazirani, "Approximation Algorithms", Springer (December 8, 2010), ISBN-10:3642084699,ISBN-13:978-3642084690

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:

Oncompletionofcourse,studentswillbe able–

1. Toformulatecomputationalproblemsmathematically
2. Toapplyappropriatealgorithmicparadigm   todesign efficientalgorithmsforcomputationalproblems
3. Toapplysuitablemathematicaltechniquesto analyzeasymptoticcomplexityofthealgorithmforacomplexcomputationalproblem.
4. To understand the significance of NP- completeness of some decision problems and its relationship within tractability of the decision problems.
5. To understand significance of randomness, approximability in computation and design randomized and approximation algorithms for suitable problems
6. To incorporate appropriate datastructures,algorithmic paradigms to craft innovative scientific solutions for complex computing problems

COattainmentlevels
Co1-1
Co2-2
Co3-3
Co4-3
Co5-4
Co6-5

FutureCoursesMapping:

AdvancedAlgorithms,   ComputationalGeometry,
AlgorithmicNumberTheory,AlgorithmicGraph   Theory,MotionplanningandRobotics,
NaturalLanguage Processing

JobMapping:

Algorithm design is an essential component of any job based on programming. All Industriesin IT Engineering always look for a strong knowledge in Algorithm design and Datastructuresforpositionslike

Developer,Architect,PrincipalEngineer,Backendleadengineer,Fullstackdevelopers,Solutionarchitect,Solution/Seniorengineer,Technicallead etc

FF No. : 654

AI3011: DEEP LEARNING

CoursePrerequisites :Machine Learning

CourseObjectives:

1. Introducemajordeeplearningalgorithms,theproblemsettings,andtheirappli cationstosolve realworldproblems.
2. Becomefamiliarwithnneuralnetworks
3. Thistopicscourseaimstopresentthemathematical,statisticalandcomputationalchalle ngesofbuildingstable representationsforhigh-dimensionaldata
4. Discussingrecentmodelsfromsupervisedlearning
5. Discussingrecentmodelsfromunsupervisedlearning

Credits:5   **TeachingScheme**   **Theory:3**Hours/Week

Tut:1 Hours/Week

Lab:2 Hours/Week

CourseRelevance: Veryessentialskillsetfor anycomputingbackgroundstudent

SECTION-I
Topicsand Contents Introduction to deep learning, Neural Network Basics, Batch Normalization, Shallow NeuralNetwork and Deep Neural Networks. Attacking neural networks with Adversarial ExamplesandGenerativeAdversarialNetworks,Practicalaspectsofdeeplearning,Optimizationalg orithms,Hyperparameter Tuning,BatchNormalization. The Neuron, Expressing Linear Perceptron as Neurons,Feed Forward Neural Networks, Linear Neurons and their Limitations, Sigmoid, Tanh andReLU Neurons. DeepLearningStrategy:Aguidetoconvolutionarithmeticfordeeplearning,Isthedeconvolutionlaye rthesameasaconvolutionallayer?,VisualizingandUnderstandingConvolutional Networks, Deep Inside Convolutional Networks: Types of CNN, VisualizingImage Classification Models and Saliency Maps, Understanding Neural Networks ThroughDeepVisualization,LearningDeepFeaturesforDiscriminativeLocalization

SECTION-II

Topicsand Contents

LSTM,Restricted Boltzmann machines (RBMs) and their multi-layer extensions Deep BeliefNetworksandDeepBoltzmannmachines;sparsecoding,autoencoders,variationalautoencoders,convolutionalneuralnetworks,recurrent   neural networks,generativeadversarialnetworks,andattention-basedmodelswithapplicationsinvision,NLP,andmultimodallearning.

Importance of Human Interpretable models, Model-Agnostic Methods such as Partial Dependence Plot (PDP), Local Surrogate (LIME), SHapley Additive exPlanations (SHAP), Example-Based Explanations such as Counterfactual Explanations, Neural Network Interpretation

Real time applications: Introduction to Natural Language Processing, Information Retrieval,MachineTranslation,ComputerVision,Speech Recognition.Detailsof each application.

ListofTutorials:(AnyThree)
1. ShallowNeuralNetworks
2. KeyconceptsonDeepNeuralNetworks
3. Practicalaspectsofdeeplearning,OptimizationAlgorithms
4. Hyperparametertuning,BatchNormalization,Programming Frameworks
5. Bird recognition inthecityofPeacetopia(casestudy)
6. Autonomousdriving(casestudy)
7. ThebasicsofConvNets
8. Deepconvolutionalmodels
9. KerasTutorial
10. DetectionAlgorithms
11. SpecialApplications:FaceRecognition&NeuralStyleTransfer
12. NaturalLanguageProcessingandWordEmbeddings
13. SequenceModelsandAttentionMechanism

ListofPracticals: (AnySix)
1. Planardataclassificationwithahiddenlayer
2. BuildingyourDeepNeuralNetwork:stepbystep
3. Deep NeuralNetwork–Application
4. Initialization,Regularization,GradientChecking,Optimization
5. Tensorflow
6. ConvolutionalModel: step bystep,
7. ConvolutionalModel:application
8. ResidualNetworks
9. Car DetectionwithYOLO
10. ArtGenerationwithNeuralStyleTransfer
11. FaceRecognition
12. DinosaurLand--Character-levelLanguageModeling
13. JazzimprovisationwithLSTM
14. OperationsonWordVectors –Debiasing
15. TriggerWordDetection

List ofCourseSeminarTopics:
1. 1.Dropout:asimplewaytopreventneuralnetworksfromoverfittin g,
2. 2.DeepResidualLearningforImage Recognition
3. BatchNormalization:AcceleratingDeepNetworkTrainingbyReducingInternalCovariateShift
4. Large scaleVideoClassificationwithConvolutionalNeuralNetworks
5. 5.Generativeadversarialnets
6. High-SpeedTrackingwithKernelizedCorrelationFilters
7. Doweneedhundredsofclassifierstosolverealworldclassificationproblems
8. ScalableNearestNeighborAlgorithmsforHighDimensionalData
9. Asurveyonconceptdriftadaptation
10. SimultaneousDetectionandSegmentation
11. Interpretation on Unstructured Datasets
12. Interpretation on Deep Learning Models

ListofCourseGroupDiscussionTopics:
1.Feature Extraction Vs Automatic Feature detection
2.RNN VsLSTM
3.SentenceClassificationusingConvolutionalNeuralNetworks
4Dog-breedClassifier
5.Generate TV Scripts
6.Generate Faces
7.Factoid QuestionAnswering
8.NeuralSummarization
9.DialogueGenerationwithLSTMs
10.ParsingandSentimentAnalysisusingRecursiveNeuralNetworks
11. The Accuracy vs. Interpretability trade-off
12. Local vs global explanation

ListofHomeAssignments:
Design:
1. Building a Recurrent Neural Network
2. CharacterlevelDinosaurNamegeneration
3. Music Generation
4. OperationsonWord vectors
5. NeuralMachinetranslationwithattention
6. Generating explanations using ELI5.
7. Generating explanations using Skater
8. Generating explanations using SHAP
9. Generating explanations using LIME

Case Study
1. AlexNet
2. VGG
3. Inception
4. ResNet
5. YOLO

Blog
1.OpenAI
2.ComputerVision
3.Google Brain
4.DeepLearningandNaturalLanguageProcessing
5.Multi-taskLearning and TransferLearning

Surveys
1.Deep
NeuralNetworksinSpeechandVisionSystems2.GANs
3.Deep Learning for big
data4.DeepLearningforNLP
5.TransferLearning

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand
checkifitcovers allaspectsofBloomsTaxonomy.
MSE   PPTPresentation   ESE   GD   Tut   Viva   Lab+CourseProject

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Text Books:(AsperIEEEformat)

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1. DeepLearningwithPythonbyFrançoisChollet,ManningPublicationsCo,ISBN:9781617294433
2. DeepLearning-
APracticalApproachbyRajivChopra,KhanaPublications,ISBN:9789386173416

ReferenceBooks:(AsperIEEEformat)

1.DeepLearningbyIanGoodfellowandYoshuaBengioandAaronCourvillePublishedbyAnMITPressbook.

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1. Developintelligentsoftwaretoautomateroutinelabor,understand   speech
orimages,makediagnosesinmedicine andsupportbasic scientific research
2. Solvingthetasksthatareeasyforpeopletoperformbuthardforpeopletodescribeformally.
3. Applydeeplearningmodelsforretrievalofinformationandmachinetranslation.
4. DevelopanartificialIntelligencesystemforthedeep neuralnetwork-based applications.
5. Evaluationofvariousalgorithmsusingdeeplearning.
6. Designofintelligentmodelusingalgorithmsofdeeplearning.

COattainmentlevels
Co1-2
Co2-2
Co3-3
Co4-4
Co5-3
Co6-5

FutureCoursesMapping:
Mentionothercoursesthat canbetakenaftercompletionofthiscourse
MS in deep learning

JobMapping:
WhataretheJobopportunitiesthat onecangetafterlearningthiscourse
Deep learning engineer, Software engineer-deep learning, senior software engineer-deep learning, deep learning analyst, deep learning scientist, research scientist-deep learning, data scientist-deep learning, senior data scientist-deep learning, deep learning specialist, deep learning R&D engineer, technical program manager-deep learning

FF No. : 654

AI3012: IMAGE PROCESSING & COMPUTER VISION

Course Prerequisites: Know ledge of Linear Algebra Different types of Signals

CourseObjectives:

1. TolearnImageProcessingfundamentals.
2. TostudyImagepreprocessingmethods.
3. Tounderstand image losslessand lossycompressiontechniques.
4. Tointroduce   themajorideas,methods,andtechniques   of computervisionandpatternrecognition.
5. ToacquaintwithImagesegmentationandshaperepresentation.
6. Toexploreobjectrecognitionanditsapplication

Credits:4   **TeachingScheme**   **Theory:3** Hours/Week

                                       Lab:2 Hours/Week

Course Relevance: Image processing and computer vision are of fundamental importance to anyfield in which images must be enhanced, manipulated, and analyzed. They play a key role inremote sensing, medical imaging, inspection, surveillance, autonomous vehicle guidance, andmore. Students of this course will benefit from the direct visual realization of mathematicalabstractions and concepts, and learn how to implement efficient algorithms to perform thesetasks.

SECTION-I

Topicsand Contents

Introduction: Elements ofimage processing system, Scenes and Images, Vector Algebra,Human Visual System, color vision color model: RGB, HVS, YUV, CMYK, $YC_bC_r$and somebasic relationships between pixels, linear and nonlinear operations. Image types (optical andmicrowave),Imagefileformats(BMP,tiff,jpeg,ico,ceos,GIF,png,rasterimageformat).Image sampling and quantization.Thresholding, Spatial domain techniques { ImageNegative, Contrast stretching, gray level slicing, bit plane slicing, histogram and histogramequalization,localenhancementtechnique,imagesubtractionandimage average.

ImageSmoothening:low-passspatialfilters,medianfiltering.

Image Sharpening:high-pass spatial filter, derivative filters, Frequency domain techniques-Ideallow-passfilter,Butterworthlow-passfilter,High-passfilter,Homo-morphicfilters.

IntroductiontoImagecompressionanditsneed:Codingredundancy,classificationofcompression techniques(Lossy andlossless-JPEG,RLE,Huffman,Shannonfano).

SECTION-II

Topicsand Contents

ShapeRepresentationandSegmentation: Contourbasedrepresentation,Region-basedrepresentation,Deformablecurvesandsurfaces,Snakesandactivecontours,Levelsetrepresentations,Fourierandwaveletdescriptors,Medialrepresentations,Multiresolutionanalysis.Classificationofimagesegmentationtechniques:WatershedSegmentation, Edge-based Segmentation, region approach, clustering techniques, edge-based,classificationofedgesandedgedetection,watershed transformation.

Object recognition: Hough transforms and other simple object recognition methods, Shapecorrespondenceandshapematching,Principalcomponentanalysis,Shapepriorsforrecognition

ImageUnderstanding:Patternrecognitionmethods, HMM,GMMandEM

AR   VR: Introduction,Real-time   computer   graphics,Virtualenvironments,Requirements forVR,benefits ofVirtualreality.

Applications:Photoalbum–Facedetection–Facerecognition–Eigenfaces–Activeappearanceand3DshapemodelsoffacesApplication:Surveillance–foreground-

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Backgroundseparation–particlefilters–Chamfermatching,tracking,andocclusion–combiningviews from

Multiplecameras–humangaitanalysisApplication:In-vehiclevisionsystem:locatingroadway–roadmarkings –identifyingroadsigns–locatingpedestrians.

VirtualRealityApplications:Engineering,Architecture,Education,Medicine,Entertainment,Science,Training.

ListofPracticals: (AnySix)

1. WriteMatlabcodetoimplementpseudocolouringoperationofagivenimage.
2. WriteMatlabCodefor Pseudo Colour ofImagebyusingGrayto colourtransform.
3. Study of different file formats e.g. BMP, TIFF and extraction of attributes ofBMP.
4. Writematlabcodetofindthefollowingstatisticalpropertiesofanimage.Mean, Median,Variance,Standard deviation,Covariance.
5. Write matlab code to enhance image quality by using following techniques Logarithmictransformation,Histogram Equalization,Gray levelslicingwith and withoutbackground,Inverse transformation.
6. ReadanImageandPerformsingularvaluedecomposition.Retainonlyklargestsingul arvaluesandreconstructtheimage.AlsoComputetheCompressionratio.
7. WritematlabcodetoenhanceimagequalitybyusingfollowingtechniquesLowp assand weightedlowpassfilter,Median filter,Laplacianmask.
8. WritematlabcodeforedgedetectionusingSobel, PrewittandRobertsoperators.
9. WriteC-languagecodetofindoutHuffmancodeforthefollowingwordCOMMITTEE.
10.Write matlab code to design encoder and decoder by using Arithmetic coding forthefollowing wordMUMMY.(ProbabilitiesofsymbolsM-0.4,U-0.2,X-0.3,Y-0.1).
11. WritematlabcodetofindoutFourierspectrum,phaseangleandpowerspectrum ofbinaryimageandgrayscaleimage.
12. Develop an algorithm for pre-processing of an input image for geometric transformation ofimage.
13. Developanalgorithmforpre-processingofaninputimageforenhancementofimage.
14. Developanalgorithmforfeatureextractionofaninputimageusingpointdetector
15. Developanalgorithmforsegmentationofaninputimage
16. Developanalgorithmforrecognitionofanobjectfrominputimage
17. Developanalgorithmformotionestimationfromagivenvideosequence.
18. DesignanalgorithmforSVMclassifier
19. Designanalgorithmforadaboostclassifier
20. Linedetectionusing Houghtransform
21. DesignanddevelopopticalflowalgorithmforMotionEstimation

ListofProjects:
1. LosslessandLossyCompressionTechniques
2. PseudoColourImageProcessingModel.
3. ImageandVideo Enhancement models
4. HumanMotionDetection
5. ObjectDetectionModel
6. FaceRecognitionModel
7. DynamicTextureSynthesis
8. ImageandVideo Editing
9. Develop an application for a vision-based security system during day/night time. Thesystemshouldtriggeranaudio-visualalarmuponunauthorizedentry.
10. Develop motion estimation/ tracking system to recognize object of interest related to oneofthefollowing applications.(Automobiletracking/ facetracking/ humantracking).
11. Develop motion estimation/ tracking system to recognize object of interest related to oneofthefollowingapplications.(Spacevehicletracking/solarenergytracking/crowdpatterntracking).

List ofCourseSeminarTopics:
1. Linear AlgebrausedforImageProcessing
2. ImageFileformat-TIFF
3. ColorModel
4. PseudoColourImageProcessing
5. ImageEnhancement-SpatialDomain
6. ImageSmoothening
7. ImageEnhancement-FrequencyDomain
8. ImageSharpening
9. ImageSegmentation
10. WatershedTransformation
11. 3-D model
12. FaceDetection
13. Object Recognition

ListofCourseGroupDiscussionTopics:

1. LossyCompressionTechniques,
2. LosslessCompressionTechniques,
3. FourierTransform,
4. SetPartitioninginHierarchicalTrees-SPIHTWavelet Transform,
5. ImageUnderstanding-PatternRecognitionModels
6. ObjectRecognitions,
7. 3-Dmodelsanditsapplications,
8. WaveletTransform,
9. Facedetectionmodels,etc.

ListofHomeAssignments:
Design:
1. Design3-Dmodels
2. FaceDetectionModels
3. Developan   applicationforavision-basedsecurity   system duringday/nighttime.Thesystemshouldtriggeranaudio-visualalarmuponunauthorizedentry.
4. Develop motion estimation/ tracking system to recognize object of interest related to one ofthefollowing applications.(Automobiletracking/facetracking/ humantracking).
5. Develop motion estimation/ tracking system to recognize object of interest related to one ofthe following applications. (Space vehicle tracking/ solar energy tracking/ crowd patterntracking).

Case Study:
1. ImageProcessingforSmart City
2. ComputerVisionforAR AVR
3. ResearchAreas inImageProcessing&ComputerVision
4. ImageProcessingforSwasthaBharat
5. ImageProcessinginIoT
6. ComputerVisioninHealthAnalytics
7. ComputerVisioninwearablecomputing

Blog:
1. ComputerVisionforDataScience
2. ImageProcessingforSmartAgriculture
3. ImageProcessinginMedicalField
4. UsageofAI forComputerVision
5. JobOpportunitiesinImageProcessingandComputerVision
6. UsageofImageProcessinginComputerVision,MachineLearning,DeepLearning,andAI

Surveys

1. SteganographyandCryptography
2. ImageProcessingforEducations
3. DynamicTextureSynthesis
4. ClassificationsandRecognitions
5. Image&Video Compression
6. DronebasedSurveillance
7. VideoEditing
8. HumanMotion/Objecttrackinganddetections
9. ImageProcessingusingHigh-PerformanceComputing-Computational
10. Complexity/TimeComplexityandExecutiontime
11. Recent TrendsinImageandVideoProcessing

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand
checkifitcovers allaspectsofBloomsTaxonomy.
MSE   ESE   LAB+CourseProject   GD   PPT   VIVA

Text Books:(AsperIEEEformat)

1. RafaelGonzalez&
   RichardWoods,"DigitalImageProcessing,"3rdEdition,Pearsonpublications,ISBN
   0132345633.
2. S.Jayaraman,SEsakkirajan,&TVeerakumar,"DigitalImageProcessing,"TataMcGrawHillEdu
   cation,ISBN(13)9780070144798.
3. AnilK.Jain,"FundamentalofDigitalImageProcessing,"5thEdition,PHIpublication,ISBN
   13:9780133361650.
4. RichardSzeliski,"ComputerVision:AlgorithmsandApplications(CVAA)",Springer,2010.
5. E.R.Davies,"Computer&MachineVision," FourthEdition,AcademicPress,2012.
6. SimonJ.D.Prince,"ComputerVision:Models,Learning,andInference",CambridgeUniversity
   Press,2012.

ReferenceBooks:(AsperIEEEformat)

1. Pratt, "DigitalImageProcessing,"WileyPublication,3rdEdition,ISBN0-471-37407-5.
2. K.R.Castleman,"DigitalImageProcessing,"3rdEdition,PrenticeHall:UpperSaddleRiver,NJ,3,I
   SBN 0-13-211467-4.
3. K.D.Somanand   K.I.Ramchandran,"Insightintowavelets-Fromtheoryto   practice,"
   2ndEditionPHI,2005.
4. D.ForsythandJ.Ponce, "ComputerVision-A modernapproach,"PrenticeHall
5. E.TruccoandA.Verri,"IntroductoryTechniquesfor3DComputerVision,"Publisher:Prentice
   Hall.
6. D.H.Ballard, C.M.Brown, "ComputerVision", Prentice-Hall,EnglewoodCliffs,1982.

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1.ApplylosslessandLossycompressiontechniquesforimagecompression.

2. Designfiltersforimagesharpeningandsmoothening.
3. Explorepre-processingalgorithmstoacquiredimages
4. ExtractfeaturesfromImagesanddoanalysisofImages
5. Understandvideoprocessing,motioncomputationand3Dvisionandgeometry
6. MakeuseofComputer Visionalgorithmstosolvereal-worldproblems

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COattainmentlevels

CO1-2
CO2-3
CO3-2
CO4-3
CO5-4
CO6-5

FutureCoursesMapping:

ARVR,NLP,VideoAnalyticsusing GPU

JobMapping:
Whatare theJobopportunitiesthat onecanget afterlearningthiscourse
Image Processing Developer, Machine Vision Engineer, Associate Data Scientist ComputerVision, Data Scientist Image Processing,Computer Vision, Lead Scientist - Image Analytics &Signal Processing, Software Development Engineer - Image Processing, Image Processing &Computer Vision Engineer,Medical Image Processing Engineer, Architect - Video and   ImageProcessing,Lead-MedicalImageAnalysisDeveloper,ResearchEngineer-ImageProcessing,ImageAnalysisScientist-ImageProcessing/PatternRecognition.

FF No. : 654

AI3013: BUSINESS INTELLIGENCE

CoursePrerequisites: DatabaseManagementSystems,BasicProbabilityandStatistics

CourseObjectives:

1. Studydata pre-processingtechniques
2. Understandthedata modeling requiredforbusinessintelligencerelatedtasks
3. Understandtheroleofstatisticaltechniquesindataanalysistasks
4. Studybigdata analysistechniques
5. Usedifferentreporting/visualizationtools

Credits:5   **TeachingSchemeTheory:3**Hours/Week

                                         Tut:1 Hours/Week

                                         Lab:**2**Hours/Week

CourseRelevance:

This course is very useful as it aims in applying statistical techniques for analyzing data to helpmanagerialpeoplemakeinformeddecisions.Itcoversdatapreprocessing,modelingandvisualization tasks thoroughly to give insight into the life cycle of a BI task. It makes studentsexplorevariousanalysistechniqueswhicharealsostudiedinvariousadvanceddatamanagementrelatedcourses.

<div style="border:1px solid black; text-align:center;">

SECTION-I

</div>

Topicsand Contents

Introduction: What is business intelligence (BI)? Need for BI. Drawing insights from data:DIKW pyramid, levels of decision making (strategic, tactical and operational BI). Examples ofbusinessanalyses–funnel analysis,distributionchannel analysisand performanceanalysis.

Data Preprocessing: Notion of data quality. Typical preprocessing operations: combiningvalues into one, handling incomplete/ incorrect / missing values, recoding values, sub setting,sorting,transformingscale,determiningpercentiles,removingnoise,removinginconsistenci es, transformations, standardizing, normalizing - min-max normalization, z-scorestandardization.

Data Warehousing: What is a data warehouse, need for a data warehouse, architecture, datamarts, OLTP vs OLAP, Multidimensional Modeling: Star and snow flake schema, Data cubes,OLAPoperations,DataCubeComputationandDataGeneralization,Datalake

EnterpriseReporting: Metrics,Measurement,Measures,KPIs,Dashboards,Reports,Scorecards

InferentialStatistics: Roleofprobabilityinanalytics,probabilitydistributionsandtheircharacteristi cs. Need for sampling, generating samples, sampling and non-sampling error.Sampling Distribution ofMean, Central Limit Theorem, Standard Error. Estimation: Pointand IntervalEstimates,ConfidenceIntervals,levelofconfidence,sample size.

Hypothesis Testing: Basic concepts, Errors inhypothesis testing, Power of test, Level ofsignificance,p-value,generalprocedureforhypothesistesting.Parametricandnon-parametric tests – z test, t test, chi-square test.Two tailed and one-tailed tests. Chi-square testforindependenceandgoodness offit. ANOVA.

Predictive Analytics: Similarity Measures: Design of recommender systems: user based oritem basedcollaborativefiltering.

SECTION-II

Topicsand Contents

Data Modeling and visualization: Logic driven modeling, data driven modeling, basic what-ifspreadsheet models**,** Role of visualization in analytics, different techniques for visualizing databasedonthe nature ofdataandwhatkindofinsightsneedtobe drawn

IntroductiontoTimeSeriesAnalysisandForecasting: Timeseriespatterns,forecastaccuracy,movingaveragesandexponentialsmoothing,casualmodels,usingregressionanalysisforforecasting,determiningbestforecastmodeltouse,ARIMAmodels

Prescriptive/OptimizationAnalytics: Overviewofsimulationandriskanalysis,LinearOptimizationModels(linearprogramming),IntegerLinearOptimizationmodels(integerprogramming), Non-linear optimization models (portfolio theory), Monte Carlo Simulation,DecisionAnalysis

BigDataAnalytics:

What is Big Data, sources of BigData, MapReduce, Hadoop, visualizing bigdata. multi variateanalytics, Text Analytics, Web Analytics, Social Media Analytics, Mobile Analytics, Mobile BI,Analytics in the Cloud, Embedded BI, NoSQL databases for Unstructured Data, In MemoryAnalytics–rowvscolumnardatabases,in-memorydatabases,DataStreamAnalytics,CustomerCentricity,PatientCentricity,IoT,Self-ServiceBI,Fognetworks

ListofTutorials:(AnyThree)
1. Understand Architectureofadatawarehouse,datamarts
2. Designamulti-dimensionaldatamodelusingstar/snowflakeschematechniqueforanybusinessfactcorrespondingto a departmentofanorganization.
3. ImplementthedesignedschemaandcreatecubesusingSSAS.
4. DataIntegration:Createtwodistinctdatasources(e.g.textfile,relationaldatabaseandExcel,etc)an dapplyETLprocessusingSSIStoloaddatainthe createdcube.
5. UseSSRSfunctionalitiestogeneratereportsanalyzingthedesignedcube.
6. UseRstatisticalpackagetounderstand/identifysalientcharacteristicsofdata
7. Applystatisticalanalysistechniquestoadatasettodrawinferences
8. PerformBigDataanalyticsusingmap-reduce.

9. CreatingKibanavisualizations

10. Applyvisualization/ reporting toolto gain insightsinto data

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ListofPracticals: (AnySix)

1. Demo of business Analytics Tool, QlikView with a scenario-based application to understandwhatbusinesses dowiththeirdata

2. Designagalaxyschemafor asetofbusinessprocessesbyconsidering anorganization

3. UseRcommandstoperformstatisticalanalysisona givendataset,

4. PerformHypothesisTesting, Chi-squaretest

5. Performwhat-ifanalysis

6. BigdataAnalytics-Hive fordataanalysis

7. AnalysisusingvariousOLAPcubeoperations

8. Createadashboardfor anorganization

9. Performregressionanalysisonadatasettopredictvalueofdependentvariable

10. Performprescriptive/optimizationanalysisonasuitabledataset

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ListofProjects:

1. BI case study involving multi-dimensional modeling, data cube, ETL (PDI), OLAP (PivotTablesinExcel),enterprisereporting(dashboardsandreports).Endtoenddatawarehousing using Pentaho/Mondrian/ QlikView/ Excel/Tableau/ PowerBI.

2. Datapreprocessing,ExploratoryAnalysis,VisualizationusingR

3. CorrelationandRegressionAnalysisusingR

4. BigdataAnalytics-Rover Hadoop/Pig/ HBase

5. Considerarealworldproblem(sayfromadatasciencecompetitionlikekaggle)andsolveitusingth eabovelearnedconcepts

6. PerformTime SeriesAnalysisona datastream

7. Buildaofrecommendersystemforanonlineshoppingwebsite

8. Demonstratehowaglobalindustrialmanufacturingcompanyusesbusinessintelligencetoproduc emore precise demandforecastsforefficientmanufacturingplanning.

9. Demonstratehowachildren'sfashioncompanyusesbusinessintelligencetoprocessretaildata frommanystorestostreamline thecustomerexperience.

10. Demonstratehowarestaurantoperatorusesbusinessintelligencetoanalyze328millionreceiptlin eitemsperyeartobettermanagetherestaurant operations.

List ofCourseSeminarTopics:
1. EmbeddedBI
2. MobileanalyticsandMobileBI
3. BusinessIntelligenceValueChain
4. RealtimeBusinessIntelligence
5. ChallengesofBI
6. ModernBusinessIntelligence
7. EnterprisePerformanceLifeCycle(EPLC)Framework
8. MultiplicityofBusinessIntelligenceTools
9. ManagingTotalCostofOwnershipforBusiness Intelligence
10. MicrosoftPowerBI

ListofCourseGroupDiscussionTopics:
1. HumanFactorsinBIImplementation
2. Ethicsandbusinessintelligence
3. DynamicrolesinBusinessIntelligence
4. OLAPandOLTP
5. FactorsthatAffectTotalCostofOwnership
6. CompetitiveintelligenceandBusinessintelligence
7. OperationalintelligenceandBusinessintelligence
8. BusinessAnalyticsvs.Businessintelligence
9. TraditionalBIand modernBI
10. Self-ServiceBusinessIntelligence

ListofHomeAssignments:Design:

1. HRdashboard
2. MarketingLeaddashboard
3. SalesGeographydashboard
4. Financialdashboard
5. Diseasetracker

Case Study:

1. SaaSBusinessintelligence
2. MySQLBusinessintelligence
3. Tableau
4. BIusers
5. IBMCognos

Blog

1.BIdashboardbestpractices

2. TrendsinBusinessintelligence
3. AdvantagesanddisadvantagesofBI
4. Howtodevelop asuccessfulBIstrategy
5. SASBI

Surveys

1. ETLtools
2. BIforon-timedelivery
3. BIresearch
4. AIapplicationsforBI
5. BIthroughDataVisualization

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand
checkifitcovers allaspectsofBloomsTaxonomy.

MSE ESE   Seminar GD   HA   viva   lab

Text Books:(AsperIEEEformat)

1.BusinessAnalyticsbyJamesREvans,Pearson

2.DataMining:ConceptsandTechniques",JiaweiHanandMichelineKamber,MorganKaufman, ISBN 978-81-312-0535-8, 2nd Edition for overview of data mining, OLAP and cubetechnology,datapreprocessing

3."Fundamentals of Business Analytics", by R. N. Prasad, SeemaAcharya,ISBN: 978-81-256-3203-2, Wiley-India – Types of Digital Data, OLTP-OLAP, Introduction to BI (ch 4 and 5),dataintegration(ch6),MDDM(ch7),Reporting(ch8,9)

4. HandbookofDataMining–fordatacollection,preparation,quality and visualizing(ch 14)

5. BusinessAnalyticsformanagers,WolfgangJank–exploringand   discovering ata(ch2),DataModeling(ch3,4,5,6)

6. EssentialsofBusinessAnalyticsbyCamm,Cochran,Fry,Ohlmann,Anderson,Sweeney,Williams,Cengag eLearning

7.TheKimballGroupReader:RelentlesslyPracticalToolsforDataWarehousingandBusinessIntelligence20 10,RalphKimball,MargyRoss,Wiley Publications

8. "TheDataWarehouseToolkit–
CompleteGuidetoDimensionalModeling"byRalphKimballandMargyRoss,WileyComputer Publishing

ReferenceBooks:(AsperIEEEformat)

1. BusinessIntelligence forDummies

2. "AdvancedEngineeringMathematics"byErwinKreyszig,JohnWiley&SonsInc.,10thEdition

3. AppliedBusinessStatistics: MakingBetterBusinessDecisions(English) 7th EditionbyKenBlack,WileyIndia

4. Forecasting:PrinciplesandPractices,RobJHyndman, GeorgeAthanasopoulos,Otexts

5. InformationDashboardDesign:Theeffectivevisualcommunicationofdata,StephenFew,O'Reilly

6. The Data Warehouse Toolkit - The Complete Guide to Dimensional Modeling (2nd Ed2002Wiley)-Kimball&Ross

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1. Construct an end-to-end data warehousing solution for business intelligence involvingvariousdatasources,ETL,multi-dimensionalmodeling,OLAP,reportingandanalytics
2. Evaluatevariousdataprocessingalgorithmsintheirapplicabilityto differentproblems
3. Displaytheprocessofconvertingdataintoauserdefinedformatrequiredforparticularanalysis
4. Utilizestatisticaltools inderivinginsights fromdata
5. Describevarioustechniquesfordescriptive,predictiveandprescriptiveanalytics
6. Applyvarioustechniquestosolvereal-worlddataanalysisproblems

COattainmentlevels
Co1-2
Co2-2
Co3-2
Co4-3
Co5-4
Co6-4

FutureCoursesMapping:

Mention othercoursesthat canbtakenaftercompletionofthiscourse
MS in business intelligence

JobMapping:
WhataretheJobopportunitiesthat onecanget afterlearningthiscourse
Business intelligence engineer, Business intelligence analyst, Business intelligence application developer, Business intelligence solution architect, senior business analyst, data engineer-business intelligence, Business intelligence project manager, business analyst-technology research, manager business intelligence, data engineer-business intelligence, software developer-business intelligence

HONOUR: Project

Following are the indicative project list mentioning broad areas. Students can do projects in one of the following, a combination of multiple topics or areas which is not mentioned here in consultation with the instructor.

1. Time series forecasting
2. Fault detection and diagnosis system
3. Implementation of Classification Algorithms for any real-world application.
4. Implementation of Clustering Algorithms for any real-world application.
5. Implementation of Regression Algorithms for any real-world application.
6. Implementation of Association Rule Mining Algorithms for any real-world application.
7. Prediction and forecasting
8. Pattern classification using statistical, fuzzy or neural classifiers
9. Pattern clustering for real applications
10. Any research-oriented work to update basic method in ML
11. Stock market analysis and prediction
12. Multivariate Linear regression and analysis
13. Application of classification and clustering techniques to image data.
14. Application of classification and clustering techniques to text data.

BTechAI&DSModule-VII (B20Pattern)

Subject head	Coursecode	Course name	Contact hours perweek			Credits
			Theory	**Lab**	**Tut**	
S1(OE1)	**MD4201**	**EngineeringandManagerialEconomics**	2	0	0	2
S2(OE2)	**AI4001**	**BlockChain&cybersecurity**	2	0	0	2
	AI4002	**OptimizationTechnique**	2	0	0	
	AI4003	**HumanComputerInteraction**	2	0	0	
	AI4004	**PatternRecognition usingFuzzyNeuralNetworks**	2	0	0	
	AI4005	**SoftwareEngineering**	2	0	0	
S3(OE3)	**AI4006**	**DataVisualization**	2	0	0	2
	AI4007	**Informationretrieval**	2	0	0	
	AI4008	**Augmented RealityandVirtualReality**	2	0	0	
	AI4009	**InternetofThings**	2	0	0	
S4	**AI4010**	**ENGINEERING DESIGN AND INNOVATION –III**				**10**

BTechAI &DSModule-VIII (B20Pattern)

Subjecthead	Coursecode	Course name	Contact hours perweek			Credits
			Theory	**Lab**	**Tut**	
S1	**AI4051**	**IndustryInternship**				**16**
OR						
S2	**AI4052**	**InternationalInternship**				**16**

OR						
S3	**AI4053**	**ResearchInternship**				**16**
OR						
S4	**AI4054**	**ProjectInternship**				**16**

FFNo.:654

AI4001::Block Chain & cyber security

CoursePrerequisites: Computer Networks, knowledge of any programming Language (C/C++/Java/Python)

CourseObjectives:

1. TostudybasicsofBlockchain Technology,itsapplicationsand different typesofusecases

2.ToacquireknowledgeofsmartcontractsinethereumBlockchainandHyperledgerfabric.

3.To acquire knowledge of standard algorithms and protocols employed to provideconfidentiality,integrityandauthenticity.

4.Todeployencryptiontechniquesto ensuredataintransitacrossdatanetworks.

5.To enhance awareness about Personally Identifiable Information (PII), InformationManagement,cyberforensics

Credits: 2   **TeachingScheme   Theory:2**Hours/Week

 CourseRelevance:

During the course, students will learn more about the history, the most important blockchainconcepts,thephilosophyofdecentralizationbehindblockchain,andthemaindiscussionsha ppeningwithintheblockchainenvironment.Inaddition,youwilllearnabout(potential)applications of blockchain and the impact it could have on the business world. Thiscourse Provides an in-depth study of the rapidly changing and fascinating field of computerforensics.Combines both the technical expertise and the knowledge required to investigate,detect and prevent digital crimes.Knowledge on digital forensics legislations, digital crime,forensicsprocessesandprocedures,dataacquisitionandvalidation,e-discoverytoolsE-evidence collection and preservation, investigating operating systems and file systems, networkforensics,artofsteganographyandmobile deviceforensics.

SECTION-I

Topicsand Contents

Introduction to Blockchain: Features & Industry Applications of Blockchain, Centralized &DecentralizedSystemwithExamples, DecentralizedSystem&DistributedLedgerTechnology

Blockchain Computing Power, Hash & Merkle Tree with Hands on Examples, Multiple Use-CasesofBlockchain asperdifferentindustriesandgovernment,BlockchainforTechnology:

Blockchain in Technology, Business and Management, Different Types of Blockchain, PublicBlockchain, Private Blockchain, Federated Blockchain with Examples and Difference, DigitalSignaturesandDemoofBlockchainTools,BlockchainApplicationsandusecasesinGovernment,RealTimeUseCaseApplicationsinBlockchain:ConsensusandTypesofConsensuswithexamples SmartContracts inBlockchain,NeedofSmartContractswithExamples Practical Hands-On with Smart Contracts, Developing Smart Contracts, IndustryusecasesofSmartContracts,SmartContractsforBusinessandProfessionals:SmartContracts in Detail Developing own Smart Contracts, Programming basics of Solidity (DataTypes) and Advanced Solidity, EVM in relation with Smart Contracts and Gas Price, Runningand Debugging Smart Contracts in Remix (Detailed), Deploy and Debug Smart Contract withTruffle

Smart Contracts in Ethereum Blockchain, Crypto-Economics and Cryptocurrency, Types ofCryptocurrency andCryptography,Cryptonomics and Cryptocurrency Transactions,ValidandInvalidTransactions,PrevioususecasesofCryptocurrency,Bitcoinindetail: HowBitcoin System works, Decentralized Cryptocurrency and its use cases, Making your ownCryptocurrencywithDevelopmentanddeployment,PermissionedBlockchain(RAFTConsensus, Byzantine General Problem, Practical Byzantine Fault Tolerance), Blockchain forEnterprise–Overview,BlockchainComponentsandConcepts,HyperledgerFabric–TransactionFlow

Hyperledger Fabric Details, Fabric – Membership and Identity Management, HyperledgerFabricNetworkSetup,FabricDemoonIBMBlockchainCloud,FabricDemoonIBMBlockchain Cloud continued., Fabric Demo, deploy from scratch, Hyperledger Composer – Application Development, Hyperledger Composer – Network Administration, Blockchain UseCases.

SECTION-II

Topicsand Contents

Introduction and Overview of Cyber Crime, Nature and Scope of Cyber Crime, Types of CyberCrime:SocialEngineering,CategoriesofCyberCrime,Property CyberCrime.

CYBER CRIME ISSUES: Unauthorized Access to Computers, Computer Intrusions, Whitecollar Crimes, Viruses and Malicious Code, Internet Hacking and Cracking, Virus Attacks,Pornography,   Software   Piracy,   Intellectual   Property,   Mail   Bombs, Exploitation,Stalking
andObscenityinInternet,Digitallawsandlegislation,LawEnforcementRolesandResponses**.**

INVESTIGATION: IntroductiontoCyberCrimeInvestigation,InvestigationTools,eDiscovery, Digital   Evidence   Collection,   Evidence   Preservation,   EMail   Investigation, EMailTracking,IPTracking,EMailRecovery,HandsonCaseStudies.EncryptionandDecryptionM ethods,SearchandSeizureofComputers,RecoveringDeletedEvidences,PasswordCracking.

DIGITALFORENSICS: IntroductiontoDigitalForensics,ForensicSoftwareandHardware,Anal ysisandAdvancedTools,ForensicTechnologyandPractices,ForensicBallistics and Photography, Face, Iris and Fingerprint Recognition, Audio Video Analysis,WindowsSystem Forensics,Linux System Forensics,Network Forensics.

List ofCourseSeminarTopics:
1. DifferentIntroductiontoBlockchain
2. TypesofBlockchain
3. BlockchainApplicationsandusecasesinGovernment
4. RealTimeUseCaseApplicationsinBlockchain
5. Industryuse casesofSmartContracts
6. SmartContractsinEthereumBlockchain
7. Bitcoin
8. BlockchainforEnterprise
9. HyperledgerFabric
10. HyperledgerComposer

ListofCourseGroupDiscussionTopics:
1. IntroductiontoCyberSpace
2. ClassificationofMalware,Threats
3. VulnerabilityAssessment
4. Biometric AuthenticationMethods
5. OperatingSystemSecurity
6. WebSecurity
7. EmailSecurity
8. MobileDeviceSecurity
9. CloudSecurity
10. DifferentTypesofCyberCrimes,ScamsandFrauds
11. Stylometry,IncidentHandling
12. DigitalForensicInvestigationMethods
13. DigitalForensicInvestigationMethods
14. EvidentiaryvalueofEmail/SMS, CybercrimesandOffensesdealtwithIPC
15. RBIActandIPRActinIndia
16. JurisdictionofCyber Crime,Cyber SecurityAwarenessTips

ListofHomeAssignments:
Design:

1. TCPScanningUsingNMAP.
2. PortscanningUsingNMAP.
3. TCP/UDPConnectivityusingNetcat
4. Creatingwalletsandsendingcryptocurrency
5. StartingaWordpresswebsite

Case Study:
1. NetworkVulnerabilityusing OpenVAS
2. ThePracticeofWebApplicationPenetrationTesting
3. ToimplementSQLinjectionmanuallyusingDamnVulnerableWebApp
4. Crypto-anarchismandCypherpunks
5. Hashcryptography,miningandconsensus

Blog
1. PracticalIdentificationofSQL-InjectionVulnerabilities
2. Stylometry,IncidentHandling
3. InvestigationMethods
4. Tokenizationandtradingcryptocurrencies
5. SmartcontractsanddApps

Surveys
1. DigitalForensicInvestigationMethods

2. DigitalForensics
3. VirtualCurrency
4. IoTSecurity
5. ThecurrentstateoftheBlockchainlandscape

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand
checkifitcovers allaspectsofBloom'sTaxonomy.
MSE   ESE   PPT   GD   VIVA HA

Text Books:(AsperIEEEformat)

1. *NelsonPhillipsandEnfingerSteuart,"ComputerForensicsandnvestigations",Cengageearning,NewDelhi,2009.*
2. *NihadHassan,RamiHijazi,Apress,"DigitalPrivacyandSecurityUsingWindows:APracticalGuide".*
3. *"DigitalForensics",DSCI -Nasscom,2012.*
4. *"CyberCrimeInvestigation",DSCI -Nasscom,2013*
5. *KevinMandia,ChrisProsise,MattPepe,"IncidentResponseandComputerForensics",TataMcGraw-Hill,NewDelhi,2006.*

*ReferenceBooks***:(AsperIEEEformat)**

1. *RobertMSlade,"SoftwareForensics",Tata McGraw-Hill,NewDelhi,2005.*
2. *BernadetteHSchell,ClemensMartin,"Cybercrime",ABC–*
CLIOInc,California,2004.3."UnderstandingForensicsinIT",NIITLtd, 2005.

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1. Identifythreadsincybersecurity.
2. Usetoolsfordigitalforensics.
3. InvestigateandAnalyzedataofcybersecurity.
4. Usetheblockchaintechnologyforsecurityinreallifeapplication.
5. Studyandunderstandtheblockchainconceptsandtoolsrequiredforits implementation.
6. Developtheapplicationsofblockchainforsolvingsocialproblems.

COattainmentlevels
CO1-2
CO2-3
CO3-4
CO4-4
CO5-5
CO6-5

Future Courses Mapping:

Advance Blockchain Technology

EthicalHacking

JobMapping:
BlockchainDeveloper
Bitcoincryptocurrencydeveloper
Business Analytics
Associateprotectingnetworks,
Securingelectronicassets,
preventingattacks,ensuringprivacy,
Buildingsecureinfrastructure

AI4002::OptimizationTechniques

CoursePrerequisites: Datastructure,computerprogramming

CourseObjectives:

1. Toformulatemathematicalmodelsofbusinessproblems.
2. Tolearneffectiveprojectmanagementandplanningofresources.
3. To make optimalutilizationofresources.
4. Toreducelogisticcostsofthesupplychain.
5. Tounderstandformulationofoptimalstrategiesinaconflictandcompetitiveenvironment.
6. Tounderstandthesignificanceandmethodsofinventorymanagement.

Credits:2   **TeachingSchemeTheory:2Hours/Week**

CourseRelevance: Thiscourseiswidelyapplicableinsoftwareandmanufacturingindustriestoimprove productivityandquality.

SECTION-I

Topicsand Contents

LinearProgramming:EssentialsofLinearProgrammingModel,PropertiesofLinearProgramming Model, Formulation of Linear Programming, General Linear ProgrammingModel,Maximization&MinimizationModels,GraphicalMethodforSolvingLinearProgramming problems, Unbounded LP Problem, Additional Variables Used In SolvingLPP,MaximizationCase,MinimizationProblems,BigMMethod,DegeneracyinLPProblems,UnboundedSolutions inLPP,MultipleSolutions inLPP.

CPM/PERT:PERT/CPMNetworkComponents,RulesinConstructingaNetwork,Scheduling of Activities: Earliest Time and Latest Time, Determination of Float and SlackTimes,Critical Pathmethod forprojectmanagement,ProjectEvaluation ReviewTechnique

–PERT,Ganttchart(timechart).Terminology.

Sequencing:TypesofSequencingProblems,AlgorithmforSolvingSequencingProblems,Processing n jobsthrough 2,3,mmachines.Processing 2jobsthroughmachines.

SECTION-II

Topicsand Contents

Transportation:GeneralMathematicalmodeloftransportationproblem,Thetransportation algorithm, Method of finding initial solution: North west corner method,Least cost method, Vogel's Approximation method, Test for optimality: MODI method,Variationintransportationproblems.

Game Theory: Terminologies of game theory, Two-person-zero-sum-game, Game with purestrategy, Methods of solving game with mixed strategy, Dominance Property, Graphicalmethodfor 2xnandmx2games.LinearProgrammingapproachforgames theory,

Inventory Management: Inventory Control Models: Purchase model with instantaneousreplenishment with and without shortages, calculate EOQ, classification of inventory likeABC-Always, Better, Control, FSN –Fast, Slow and non-Moving, VED -Vital, Essential,Desirableetc

List ofCourseSeminarTopics:
1. FormulationofLinearProgramming
2. SimplexMethodofsolvingLPPproblem.
3. PrimalToduelwithexampleand solutionofproblem
4. DegeneracyinLPPProblems
5. BigMmethod
6. CPM/PERT
7. Sequencing-Processingnjobsthrough2,3machines
8. Processing2jobsthroughmmachines
9. Queuing
10.SequencingVsQueuingtechniques

ListofCourseGroupDiscussionTopics:
1. ComparisonofTransportation-N-WCornermethodandLeastcostcellmethod.
2. Transportation-VAMmethod.
3. Two-person-zero-sum-game,Gamewithpurestrategy.
4. Methodsofsolvinggamewith mixedstrategy.
5. Inventory-Purchasemodelwithinstantaneousreplenishmentwithshortagesand   without shortages.
6. Discussinventoryclassificationtechniques
7. Comparativeanalysesofpurchasemodels
8. EOQ
9. Inventorycontrolmodels
10. Transportation-MODImethod

ListofHomeAssignments:

Design:
1. DesignnetworkactivitydiagramusingCPMforconstructionworkofbuilding.
2. Designnetworkactivitydiagramusing CPMfora researchwork.
3. DesignatransportationmodelusingVAM–Vogel's Approximationmethod.
4. Designoptimalstrategiesfortwoplayers-Zerosumgame.
5. Designmathematicalmodelforabusinessproblem.

Case Study:
1. Writeacasestudyongoalprogrammingforan IT startupcompany.
2. Casestudyonprojectcrashingofasoftwaredevelopmentcompany.
3. Writeacasestudyonspecialcasesinlinearprogramming.
4. Writeacasestudyonprojectmanagement.
5. Writeacasestudytoimproveasalesofamanufacturingcompany.
6. Writeacasestudyonclassificationofinventory.

Blog
1. OptimizationTechniques-Aquantitativeperspectivetodecisionmaking.
2. Themethodologytosolveoptimization problems.
3. Writeablogonnon-linearingprogramming
4. WriteablogonapplicationsofOptimizationTechniques.
5. WriteablogonLinear Programmingapproachforgamestheory.

Surveys:
1. Takethe surveyofapplicationsoflinearprogramming.
2. Takethesurveyofdifferenttransportationmodels.
3. Takesurveyinventoryclassificationmodels.
4. Takethe surveyofoptimizationtechniquesindatascience
5. Takethesurveyofoptimizationtechniquesinshortestpathfinding

SuggestanassessmentScheme:

SuggestanAssessmentschemethatisbestsuited   for   the course.Ensure360degreeassessmentandcheckifitcovers allaspects ofBloomsTaxonomy.
MSE   ESE   PPT   GD   VIVA HA

Text Books:(AsperIEEEformat)

1. *KantiSwarup,GuptaP.K.,ManMohan,"OperationsResearch",12thEdition; SultanChand&Sons,NewDehli.*
2. *R.Panneerselvam,"OperationsResearch",2ndEdition,   PHILearningPrivateLtdNewDehli.*
3. *Taha H AOperationResearchand Introduction9thEditionPearsonEducation2014*
4. *Gupta&Hira OperationsResearchRevisedEditionChand&Co.2007*

ReferenceBooks:(AsperIEEEformat)
1. *BillyE.Gillett,"AComputer–OrientedAlgorithmicApproach",1979Edition,TataMcGraw-HillPublications Company Ltd.,NewDehli.*
2. *HillerLieberman,"IntroductiontoOperationsResearch",7thEdition;TataMcGrew-hillpublishingCompany Ltd.,NewDehli*
3. *S.D.SharmaOperationsResearch 15thEditionKedarnath,Ramnath&Co*
4. *JKSharmaOperationsResearch3rdeditionLaxmiPublications2009*

MoocsLinksandadditionalreadingmaterial:
1. https://www.youtube.com/watch?v=Q2dewZweAtU
2. https://www.youtube.com/watch?v=h0bdo06qNVw

CourseOutcomes:
Thestudentwillbeableto–
1. Developlinearprogrammingmodelstosolvereallife businessproblems.(3)
2. AnalyzeCriticalpathusingCPMand PERT(3)
3. Usesequencingtechniquesforeffectiveschedulingofjobs(4)
4. Solvetransportationproblemsusing variousmethods.(4)
5. Computethevalueofthegameusingpure/mixedstrategiesandaccordingly deviceoptimalstrategies towinthe game(5)
6. Learnvarious modelsandtechniquesofinventorymanagement.(5)

COattainmentlevels

CO1-3

CO2- 3

CO3-4

CO4-4

CO5-5

CO6-5

FutureCoursesMapping:

OperationResearch, Operationsmanagement, SupplyChainmanagement

JobMapping:

OperationResearchAnalyst,Inventorymanager,Projectmanager,Operationresearchengineer.

FFNo.:654

AI4003::Human Computer Interaction

Course Prerequisites: Computer Programming,WebTechnology

CourseObjectives:

1. Understandthetheoreticaldimensionsofhuman factorsinvolvedintheacceptanceofcomputerinterfaces.

2. DescribeanduseHCIdesignprinciples,standardsandguidelines.

3. Identifythevarioustoolsandtechniquesforinterfaceanalysis,design,andevaluation.

4. DiscusstasksanddialogsofrelevantHCIsystemsbasedontaskanalysisanddialogdesign.

5. AnalyzeanddiscussHCIissuesingroupware,ubiquitouscomputingand   WorldWide   Web-relatedenvironments.

Credits:2   **TeachingSchemeTheory:2**Hours/Week

Course Relevance: This course provides an introduction to and overview of the field of human-computerinteraction(HCI).HCIisaninterdisciplinaryfieldthatintegratestheriesandmethodologiesfromcomputerscience,cognitivepsychology,design,andmanyotherareas.Students will work on both individual and team projects to design, implement and evaluatecomputer interfaces. The course is open   to   students   from   all   disciplines,   providing   them   withexperience workingininterdisciplinarydesignteams.

SECTION-I

Topicsand Contents

IntroductiontoHuman-ComputerInteraction(HCI)

Human, Definition of Human Computer Interaction, Interdisciplinary Nature, Goals, HumanFactors, Measurable Factors – Learn ability, Speed, Efficiency, Satisfaction. Early Focus onUsers,Ergonomics,Usability,TypesofUsability,UserInterface(UI),Contexts-Web,Business,Mobile,GamingApplications,CategorizationofApplications basedonHumanFactors,AccessibilityandSecurity.

Principlesand Models

EightGoldenRulesofInterfaceDesign,PrinciplesofGoodDesign,FaultyDesigns,Miller's

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Principle, Norman's Action Model, Gulf of Execution and Evaluation, Errors –Mistakes, Slips,Lapses and Violations, Guidelines for Data Display, Guidelines for Data Entry, Conceptual,Semantic, Syntactic and Lexical Model, Task Analysis, GOMS, Keystroke-Level Model, UserPersona,UIStandards andGUILibraries.

DesignProcessandInteractionStyles

Design, Three Pillars of Design, Process of Design, Ethnographic Observations, ContextualInquiry, Iterative Design, Participatory Design, Navigation Design, Visual Design, -Layout,Color, Fonts, Labeling, LUCID, Scenarios, Interaction Styles – Direct Manipulation, MenuSelection,Form-
Filling,Commands,NaturalLanguage,Internationalization,InteractionDesign Patterns.s - Apex professional bodies, Industries, international curriculum, curriculumof IIT and other prominent Universities, etc. Make the course in 2 sections - Section I andSectionII.

SECTION-II

Topicsand Contents

EvaluationTechniquesandInterfaceCategories

Expert-basedEvaluation,User-basedEvaluation,HeuristicEvaluation,CognitiveWalkthrough, Semiotic Analysis, Expert Reviews, Usability Testing, User Surveys, Interviews,Think Aloud, Acceptance Tests, Statistical Methods, Touch Interfaces, Public Place Interfaces,WearableInterfaces,TangibleInterfaces,IntelligentInterfaces,UbiquitousandContext-Aware Interaction.**DocumentationandGroupware**

Classification of Documents, Printed Manuals, Reading from Displays, Online Help, Tutorial,Error / Warning Messages, Groupware, Goals / Dimensions of Cooperation, AsynchronousInteractions,SynchronousInteractions,Online Communities,Communityware

Miscellaneous

Case Studies: Web Usability, Mobile Usability, Embedded Systems, Social Networking Sites,Messengers,E-Governance Sites,SecurityTools,e-Healthapplications

List ofCourseSeminarTopics:
1. TheFutureofSmartEverydayObjects
2. CooperativeArtifacts
3. IntelligentKitchenUtilities
4. InteractingwithSmartProducts
5. Intimate Interfaces
6. MultitouchInterfaces
7. InteractiveTables
8. Microsoft Surface Technology
9. SenseCam
10. SpokenDialogueSystems

ListofCourseGroupDiscussionTopics:1.
W3C Multimodal Interaction Activity

2. MultimodalDialogue Systems
3. TangibleInteractionwithIntelligentVirtualAgents
4. MixedandAugmentedReality
5. MultimodalGenerationforVirtualCharacters
6. Expressive VirtualCharacters
7. Recognizing and Expressing Affect
8. EmotionalInterfacesandInputDevices
9. NaturalMachines
10. DataEntryInterfaces

ListofHomeAssignments:
Design:
1. ApplyNorman'sactionmodelonthetask–'Tomakeonlinepayment'.
2. Illustratemajormodelsevolved incontextualenquirywithanexample.
3. Designaccommodationforvisuallyimpairedusersinmobileapplications
4. DesignUIforInformationKioskforaMetroTerminusRelatedUIsketches
5. Formulateauser personasofIndianUserfor ITproduct.

Case Study:
1. HCIguidelines/principlesfordesigninghome page formuseumwebsite.
2. Vitalethnographicobservations inIT products.
3. Gulfofexecutionwithrespect toleft-handed users.
4. User-basedandexpert-basedusabilityevaluationmethods.
5. Anymobileapphighlightingitsethno-culturalandaccessibilityfeatures.

Blog
1. HeuristicEvaluationusingaLikert'sscale.
2. Goldenrulesofinterface
3. Effectsofmetaphorsindesignofsocialnetworkingsites.
4. LUICD
5. Semioticanalysis.

Surveys
1. Investigatepopularityofremotesynchronouscommunicationamonguser groups.
2. e-governancewebsite
3. UbiquitousandContext-AwareInteraction
4. IterativeDesign, ParticipatoryDesign,NavigationDesign, VisualDesign
5. CognitiveWalkthroughevaluationtechnique

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand checkifitcovers allaspectsofBloomsTaxonomy.
MSE   ESE   PPT   GD   VIVA   HALAB

Text Books:(AsperIEEEformat)

1. "Human-Computer Interaction", AlanDix, JanetFinlay, GregoryD. Abowd, RussellBeale, PearsonEducation, ISBN81-297-0409-9,3rdEdition.
2. "DesigningtheUserInterface",BenShneiderman,PearsonEducation,ISBN 81-7808-262-4,3rdEdition

ReferenceBooks:(AsperIEEEformat)

1. The DesignofEveryday Things",DonaldNorman,Basic Books,ISBN 100-465-06710-7,2002Edition
2. "TheEssentialGuidetoUserInterfaceDesign",WilbertO.Galitz,Wiley-dreamtechIndia
(P)Ltd.,ISBN81-265-0280-0,2ndEdition.
3."Human-ComputerInteractionintheNewMillennium",JohnM.Carroll,PearsonEducation,ISBN   81-7808-549-6

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1.Identifyhumanfactorsandusabilityissuesrelatedwithcomputingapplications
2. Differentiatecomputingapplicationsinto categoriesbasedonhumanfactors
3. Designanuserinterfacebyapplyingsuitabledesignprinciples,modelsandusabilityguidelines
4. Integrateethno-culturalandaccessibilitycomputingaspects intotheuserinterfacedesign
5. Displaytheimpactofusabilityevaluationandtestingincomputingapplications

6.Followrequiredprocessesandstandardswhiledesigninguserinterfaces

COattainmentlevels

Co1-2
Co2-1
Co3-3
Co4-4
Co5-4
Co6-3

FutureCoursesMapping:

AugmentedRealityand Virtual Reality

JobMapping:

1. GraphicDesigner
2. User Interaction Designer
3. Product DesignManager
4. SeniorInformationArchitect

AI4004::PatternRecognitionusingFuzzyNeuralNetworks

CoursePrerequisites: Datastructure,computerprogramming,Linearalgebra

CourseObjectives:

1. Tounderstandfundamentalsofpatternrecognition.

2. Tounderstandthefuzzysetdesign

3. Tolearnfundamentalsoffuzzysetsandtheir useinpractice.

4. Tolearntrainingofhybridsystem-fuzzyneuralnetworks(FNN)

5. Toapplytrainedfuzzyneuralnetworks(FNN)forinferences.

6. TounderstandevaluatingperformanceofFNNs.

Credits:2 **TeachingSchemeTheory:2**Hours/Week

CourseRelevance: Thiscourseapplicablefor complexpatternrecognitiontasks

SECTION-I
Topicsand Contents   **Pattern recognitionfundamentals:-**   Definitionofapattern,statisticalandsyntacticpatterns,featurevector,featuredimensionality,pattern class,definitionofclassification,clustering,hybridclassification-clustering   **Introductiontofuzzysettheory:-**   Definition of fuzzy set, membership function, types of fuzzy sets, operations on fuzzy setslikeunion, intersection, compliment, plot of fuzzy membership function, core and support parts offuzzy sets

IntroductiontoArtificialNeuralnetworks:-

Biologicalneuron,McCullochPittsmodel,generalneuronmodel,perceptron,activationfunctiontypes,perceptronlearningalgorithmfor2-classclassification,singlelayerperceptron classifiersand learningalgorithms,brief introto multilayersperceptrons

SECTION-II

Topicsand Contents

Fuzzymin-maxneuralnetwork (FMN)architectureforclassification-

Concept of hyper-box, hyper-box as a fuzzy set, hyperbox membership function-definition,interpretationanduse,FMNlearningalgorithm-hyper-
boxexpansion,overlaptestandhyperbox contraction, FMN recall/testing algorithm, comments on hyperbox size, sensitivityparameterandperformanceevaluation.

Fuzzy min-max neuralnetwork (FMN) architecture for clustering-architecture, trainingalgorithm andrecallphase

FuzzyHyperlineSegmentNeuralNetwork(FHLSNN)classifier:-

Concept ofhyperline, hyperline as a fuzzy set, fuzzy membership function design, FHLSNNtrainingandtestingalgorithm,

ComparisonofFMNandFHLSNNarchitectures.

ModifiedFuzzyHyperlineSegmentNeuralNetwork(MFHLSNN) classifier:-

Modified fuzzy membership function design, convexity and normalityroperties, training and testingalgorithms,comparisonofFHLSNNandMFHLSNN

List ofCourseSeminarTopics:
1. DrawbacksinthemembershipfunctiondesignofFMN.
2. FHLSNNmembership functiondesign
3. FMNclusteringalgorithm
4. FMNclassificationalgorithm
5. Fuzzysetsandapplications
6. Fuzzy neuralnetworksashybridsystem
7. Softcomputing
8. Someothertopicsdecided byinstructor

ListofCourseGroupDiscussionTopics:
1. FHLSNNclassifierdrawbacksin membershipfunction
2. FMNapplicationinHCR
3. FHLSNNforheartdiseasedetection
4. Fuzzyclusteringtechnique
5. ComparisonofK-NNclassifierandFMNclassifier
6. Someothertopicsdecided byinstructor

ListofHomeAssignments:
Design:
1. DesignafuzzymembershipfunctionforFMNforefficiency
2. DesignafuzzymembershipfunctionforFHLSNNwithlesscostlyoperations
3. DesignFMNarchitecturefor8-Dinputpatternsfor4classes
4. DesignafuzzymembershipfunctionforFHLSNNwithoutusingsquarerootoperationsinceitis costly
5. Someothertopicsdecided byinstructor

Case Study:
1. HCRusingFHLSNN
2. Fourier Fuzzyneuralnetworkfor patternrecognition
3. FuzzyneuralnetworkbyKawnandKai
4. UFHLSNNforpatternrecognition
5. Someothertopicsdecided byinstructor

Blog
1. Fuzzyneuralnetworksashybridsystem
2. FMNforhybridclassificationandclusteringbyBargiala
3. FHLSNNmembershipfunctiondesign
4. Flaws in the contractionofhyperboxesinFMN
5. Someothertopicsdecided byinstructor

Surveys
1. EvolutionofFuzzyneuralnetworks
2. Fuzzyneuralnetworksapplicationsinhealthcare/medicaldiagnosis
3. DevelopmentsinFuzzysystems

4. Backpropagationtrainingalgorithm
5. Someothertopicsdecided byinstructor

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand checkifitcovers allaspectsofBloomsTaxonomy.
MSE   PPTPresentation   ESE   GD   Viva   LAB

Text Books:(AsperIEEEformat)

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1. *TimothyJRoss, Fuzzylogicwithengineeringapplications, 3rdeditiion, Wiley,2010*
2. *JacekM.Zurada,Introductiontoartificialneuralsystems,Jaicopublishinghouse,1992*

ReferenceBooks/Papers(AsperIEEEformat)

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1. P. K. Simpson, Fuzzy min-max neural networks Part-1. classification, IEEE TransactionsonNeuralNetworks,Vol.3(5),1992,https://doi.org/10.1109/72.159066.

2. P. K. Simpson, Fuzzy min-max neural networks Part-2. clustering, IEEE Transactions onFuzzy Systems,Vol.1(1),1993

3. U. V. Kulkarni, T. R. Sontakke and G. D. Randale, Fuzzy hyperline segment neural networkforrotationin variant andwrittencharacterrecognition,inProc.Jointconf.onNeuralNetworks:IJCNN01,WashingtonDC,USA,pp .2918-2923,July2001.

4. Pradeep M Patil, P S Dhabe, Uday V Kulkarni, TR Sontakke, Recognition of handwrittencharactersusingmodifiedfuzzyhyperlinesegmentneuralnetwork,The12thIEEEInternationalC onferenceonFuzzy Systems,2003.FUZZ'03.

5.PriyadarshanDhabe,PrashantVyas,DevratGaneriwal,AdityaPathak,Patternclassification using updated fuzzy hyper-line segment neural network and it's GPU parallelimplementationforlargedatasetsusingCUDA,InternationalConferenceonComputing,Analyticsan dSecurityTrends (CAST),2016

6. PriyadarshanSDhabe,SanmanDSabane,ImprovedUFHLSNN(IUFHLSNN)forGeneralizedRepresent ationofKnowledgeandItsCPUParallelImplementationUsingOpenMP, Springers EAI International Conference on Big Data Innovation for SustainableCognitiveComputing,2020

MoocsLinksandadditionalreadingmaterial:
1.https://www.youtube.com/watch?v=ZBCg_nH1hVQ

(VideolectureonFMNbyProf. Biswas,IITKGP)

2.https://www.youtube.com/watch?v=0e0z28wAWfg(Backpropagationalgorithm)

CourseOutcomes:

Thestudentwill beableto–

1. Designfuzzysetforagivenapplication
2. DecidearchitectureofFNNforagivenrealproblem
3. ApplyFMNforsolvingrealworldproblems
4. TrainFNN forpatternrecognition
5. TestFNNfortheir recallinpatternrecognition
6. Evaluate performance ofFNN

COattainmentlevels

CO1-2

CO2- 2

CO3-3

CO4-3

CO5-4

CO6-4

FutureCoursesMapping:

Mentionothercoursesthatcanbetaken
aftercompletionofthiscourseSoftComputing,HybridFuzzyneuro-
systems,Neuro computing

JobMapping:

WhataretheJobopportunitiesthat onecanget afterlearningthiscourse

ML-Engineer,SoftComputing-Engineer,AI-Solutionarchitect-
Fuzzyneurosystem,Predictivemaintenance-Engineer

<div align="right">**FFNo.:654**</div>

<div align="center">**IT4230::SoftwareEngineering**</div>

CoursePrerequisites: Fundamentalknowledgeaboutprogramming

CourseObjectives:

1. To learn fundamental knowledge of Software Engineering, to be successful professional inthe IT/ITESSector
2. To understand and exhibit professional and ethical principles of Software Engineering whilefunctioningasmembers,leadersofmulti-disciplinaryteams
3. Toanalyze project knowledge areaactivities todetermine abasis of successful projectexecution
4. To interpret and diagnose impact of changing project requirements using an appropriateprinciple, processes and produce specific sections of the project plan used to manage changerequests
5. TodesignanddocumentProject Managementpracticeswithinternationalstandards

Credits:2   **TeachingSchemeTheory:2**Hours/Week

Course Relevance: Industry always need talented software developers across every domain. Astechnologyadvances,theabilitytobuildqualitysoftwaresolutionconsideringdesign,development, security, and maintenance is a need. Software Engineering is a field that is vitallyimportant to Computer Technology as a whole, rather, it is a backbone of any software productdevelopment. This scientific and technically-driven field has always focus on implementation ofthe best processes and methodologies in the production of high-quality software. It developsproblem understanding and designing ability, as well as analytical and problem-solving abilityamongstlearner.Anyapplication'sfoundationstartswithanunderstandingofuserneeds,followe dby design andimplementation.AcquiringandpracticingprinciplesofSoftwareEngineering, learner can work in any domain for industry or can carry entrepreneurial activities.The purpose of this course is to present Software Engineering as a body of knowledge. Thecourse is designed to learn and experience Software Engineering concepts, principles in parallelwithumbrella activitiesand demonstrate knowledge withreallife problemstatements.

<div align="center">**SECTION-I**</div>

Topicsand Contents

Professional software development: Software engineering ethics, Software process : Softwareprocessmodels,Processactivities,Copingwithchange,Therationalunifiedprocess,RequirementEngineering:Functionalandnon-
functionalrequirements,Thesoftwarerequirementsdocument,Requirementsspecification,Requirementsengineeringprocesses,Requirements elicitation and analysis, Requirements validation, Requirements
management,Architecturaldesign,Architecturaldesigndecisions,Architecturalviews,Architecturalpatterns,Applicationarchitectures,Softwarereuse,Thereuselandscape,Applicationframeworks, Software product lines, Commercial-Off-the-Shelf (COTS) product, Component-basedsoftwareengineering,Distributedsoftwareengineering,Aspect-
orientedsoftwareengineering,Agile Development Process:Agile Development:Agile manifesto,agility andcost of change, agility principles, myth of planned development, toolset for the agile process.Extreme Programming:XP values,process,industrialXP,SCRUM -process flow,scrumroles,scrum cycle description,productbacklog,sprintplanning meeting,sprintbacklog,sprint execution, daily scrum meeting, maintaining sprint backlog and burn-down chart, sprintreviewandretrospective.

SECTION-II

Topicsand Contents

IntroductiontoProjectManagement:Projectoverview,ProjectAttributes,TheTripleConstraint, Concept of Project Management, Project Stakeholders, Project Life Cycle: ProjectPre-Initiation and Initiation, Project Planning, Project Execution, Project Monitoring andControlling, Project Closing. Project Management Knowledge Areas, Project ManagementTools and Techniques, The Role of the Project Manager, Project Manager Job Description,Suggested Skills for Project Managers, The Project Management Process Groups, ProjectKnowledgeAreas:IntegrationManagement,ScopeManagement:CreatingtheWorkBreakdownStructure,ApproachesofdevelopingWorkBreakdownStructures,TimeManagement, Cost Management : Basic Principles of Cost Management, Estimating Costs,TypesofCostEstimates,CostEstimationToolsandTechniques,ParametersofQualityManagement, Quality Standards : ISO/IEC, IEEE related to Project Management activities,Project Human Resource Management, Essentials of Project Communications Management,Risk Management : Identifying risks, Qualitative Risk Analysis , Quantitative Risk Analysis,RMMMPlan, ProcurementManagement

List ofCourseSeminarTopics:
1. AnalysisandSelectionofProcessModeltobe adopted
2. RequirementEngineering: AnArt&Science
3. Selectionofappropriate methodologiesforRequirementCollection
4. Understandingrequirementsvia notationsanddiagrams
5. Importance of Functional, Non-Functional, Domain Requirements from TestingPerspective
6. Deciding parametersforfinalizationofboundaryofrequirements
7. Commercial-Off-the-Shelf(COTS)product
8. Methodsadoptedforuseranalysis
9. IdentificationofessentialNon-FunctionalRequirements
10. AnalysisofDomainRequirementstofinalizerequirementsboundary

GuidelinesforGroupDiscussion:

Forming a group of 5 students shall be strictly based on students with different course projectofSoftwareEngineeringlaboratory.Eachstudentmustbewellawareaboutthecourseprojects of group members. Various topics listed below will be available in form of chits in abox at the time of group discussion. One of the group members will pick up the topic chit fromshuffled chit box. Participation of each group member in group discussion is mandatory sinceassessmentisindividual.

ListofCourseGroupDiscussionTopics:
1. StakeholderAnalysisandRoleofStakeholders
2. RelevanceofimplementationofTripleConstraints
3. WBSandWorkAssignmentinteam
4. Waysto handleChangeManagementIssues
5. Identificationofminimumfivepossiblepotentialriskswhensystemisunderconstructionandsteps toreducetheserisks
6. IssuestobeaddressedduringChangeManagement
7. Analysisofprojectfailures
8. ImportanceofProjectManagementdocumentsfromQualityAssuranceperspective
9. ProjectRiskIdentificationandRiskAssessmentwithStartups-
Challenges&SolutionsStylesofAgileSoftwaredevelopment
10. Requirement Tools: IBM Requisite Pro vs Contour
11. Configuration Management Tools: IBM ClearCase vs Microsoft Visual SourceSafe
12. Code Review Tools: Code Collaborator vs Cast
13. BPM Modeling tools: JBPM vs Activiti
14. Agile Project Management Tools: Rally vs Jira Agile
15. Testing Tools: Rational Functional Tester RFT vs Selenium
16. Defect Tracking Tools: JIRA vs ClearQuest

ListofHomeAssignments:

Design:

1. You want to monitor the efforts spent and the time spent on different activities of project.CanitbepossiblebyusingMSExcel?Thedesignshouldbesuchthatautomatedprocessing is possible.

2. Duringthesemesteryouaredevelopingyourcourseproject.Assumethat,youaresupposedtohand overthis   system   totheclientat   theendof   thesemester.Design adocumentcomprisinginstructions andguidelines.

3. After an application is installed (course project) at client side, it is necessary to providetraining to the users. Design stage wise trainingprogram for the users along with stagewisefeedbackformsatvariousstages oftraining

4. During   the   semesteryou   are   developingyour   course   project.   Perform costestimationtechniquesofidentifiedcourseproject.

5. While using your application, clients/users may give you some changes. Document thischange andpredictitseffectonexistingapplication.

6. A customer decides to upgrade her PC and purchase a DVD player. She begins by calling the sales department of the PC vendor and they tell her to talk to customer support. She then calls customer support and they put her on hold while talking to engineering. Finally, the customer support tells the customer about several supported DVD options. The customer chooses a DVD and it is shipped by the mail department the customer receives the DVD, installs it satisfactorily and then mails her payment accounting. Draw the UML diagram.

7. The garage is for different types of four wheelers. The advanced booking/appointment is done on phone. On the day of appointment as soon as a customer arrives, a job card is created to not all the problems, requirements for the vehicle. An engineer is assigned based on availability to service a vehicle. On completion of the repair/maintenance/service the engineer prepares a report based on which a bill is created. The payment is accepted in cash against the bill. Make suitable assumptions about scope and working of your Garage.

8. Draw a UML Class Diagram representing the following elements from the problem domain for a hockey league. A hockey league is made up of at least four hockey teams. Each hockey team is composed of six to twelve players, and one player captains the team. A team has a name and a record. Players have a number and a position. Hockey teams play games against each other. Each game has a score and a location. Teams are sometimes led by a coach. A coach has a level of accreditation and a number of years of experience, and can coach multiple teams. Coaches and players are people, and people have names and addresses.

9. A society management system maintains a list of members, maintenance paid, flat no., type of flat(owned/rented). The expenditures made are maintained with date, bill no, description of expenditure, contact details of vendor. At financial year end, the balance report is generated, which includes amount collected, expenditure, previous balance etc.

10. A college has different student associations like sports, literary, science club etc. A student can login to college website, look at the various available associations and choose one of them to join. All the associations expect you to be a valid student first. The joining process

could be different for different associations for example sports association expects you to undergo a fitness test too. The associations organize various events. A member can register for the event online for free. Non-members need to pay nominal fees by credit card to register and in either case one gets a confirmation of registration of event. The registrations information needs to be passed onto the activity that sends the email confirmations.

11. A university has an online registration system that enables the staff of each academic department to examine the courses offered by their department, add and remove courses, and change the information about them (e.g., the maximum number of students permitted). It should permit students to examine currently available courses, add and drop courses to and from their schedules, and examine the courses for which they are enrolled. Department staff should be able to print a variety of reports about the courses and the students enrolled in them. The system should ensure that no student takes too many courses and that students who have any unpaid fees are not permitted to register. (Assume that a fees data store is maintained by the university's financial office, which the registration system accesses but does not change).

Case Study:
1. Whatwentwrong?
2. Risksassociatedwithidentifiedproblem(s)
3. Effectofidentifiedrisksonexistingworkcompleted
4. Estimatetimerequiredtosolvetheissue
5. Changeindocumentscreated

Blog
1. AgileDevelopment
2. SCRUM
3. ExtremeProgramming(XP)
4. Importanceofdocumentation intotaldevelopmentprocess
5. ProfessionalcertificationsindomainofSoftwareEngineering

Surveys
1. Recenttrends inSoftwareEngineering
2. RecenttrendsinProject Management
3. Qualitystandardsrequiredessentialfor softwareproduct
4. SoftwareDevelopmentProcessAudits
5. SoftwareDesignEngineering

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand checkifitcoversallaspects ofBloomsTaxonomy.

MSE   ESE   Lab   HA   VIVA   GD   SEMINAR

Text Books:(AsperIEEEformat)

1. *Sommerville,Ian;SoftwareEngineering; 9thEdition.,AddisonWesley*
2. *Pressman Roger; Software Engineering: A Practitioner's Approach; 7th Edition, McGrawHill*
3. *BobHughes,MikeCotterell,RajibMall;SoftwareProjectManagement;6thEdition,McGrawHill JosephPhillips, ITProjectManagement–OnTrackFromStarttoFinish, TataMcGraw-Hill*

ReferenceBooks:(AsperIEEEformat)

1. *PankajJalote;SoftwareEngineeringA PreciseApproach;2010; WileyIndia*
2. *RajibMall; Fundamentals of Software Engineering; Third Edition; PHI Robert K.Wysocki;"EffectiveSoftwareProjectManagement"; O'Reilly*

MoocsLinksandadditionalreadingmaterial:
1. www.nptelvideos.in
2. www.coursera.com
3. www.udemy.com
4. www.swayam.gov.in

CourseOutcomes:
1. Understandprocessesofprofessionalsoftwaredevelopment
2. Applyappropriatelifecyclemodelofsoftwaredevelopment
3. Analyzesoftwarerequirementsbyapplyingvariousmodelingtechniques
4. UnderstandITprojectmanagementthroughprojectlifecycleandknowledgeareas
5. Applytimeandcostestimationstopredictprojectactivities
Analyzeriskassessmentactivitiestowardsdevelopmentofqualityproduct

COattainmentlevels
Co1-2
Co2-3

Co3-3
Co4-3
Co5-2
Co6-3

FutureCoursesMapping:

1. SoftwareProjectManagement
2. SoftwareQualityAssurance

JobMapping:

Business Analyst , Application Developer, Web Developer, Information Systems Engineer,SoftwareEngineeringAssociate,SystemAdministrator,ProjectManagementProfessional,Data Scientist, Full Stack Developer, Python Developer, Java Developer, Cloud Engineer,Scrum Master,TechnicalWriter

FFNo.:654

AI4006::DataVisualization

CoursePrerequisites:

Someprogrammingexperienceinanylanguage.Ideallyyouhavetakenacourseoncomputergraphics,butt hisis notstrictlyrequired.

CourseObjectives:
1. Learntodesignand createdatavisualizations.
2. Learntoconductexploratorydataanalysisusingvisualization.
3. Craftvisualpresentationsofdataforeffectivecommunication.
4. Useknowledgeofperceptionandcognitiontoevaluatevisualizationdesignalternatives.
5. Designandevaluatecolorpalettesforvisualizationbasedonprinciplesofperception.
6. Applydatatransformationssuchasaggregationandfilteringfor visualization.

Credits:2   **TeachingSchemeTheory:2**Hours/Week

CourseRelevance: VeryImportantforstrategicdecisionmakingandforecasting.Skillrequiredfordatasc ientistandbusiness analyst.

SECTION-I
Topicsand Contents **Introduction to Data Visualization**: A Brief History ofData Visualization, need of DataVisualization,GoodGraphics,StaticGraphics,DataVisualizationthroughtheirGraphReprese ntations, High-dimensional Data Visualization, Multivariate Data Glyphs: Principlesand Practice, Linked Views for Visual Exploration, Linked Data Views, Visualizing Trees andForests, Display of Geographically Referenced Statistical Data, Multidimensional Scaling,Huge Multidimensional Data Visualization, Multivariate Visualization by Density Estimation,StructuredSets ofGraphs

SECTION-II

Topicsand Contents

Methodologies:, Regression by Parts: Fitting Visually Interpretable Models with GUIDE,Structural Adaptive Smoothing by Propagation–Separation Methods, Smoothing Techniquesfor Visualization, Data Visualization via Kernel Machines, Visualizing cluster Analysis andFinite Mixture Models, Visualizing Contingency Tables, Mosaic Plots and Their Variants,ParallelCoordinates:Visualization,Exploration,andClassificationofHigh-DimensionalData,Matrix Visualization,VisualizationinBayesianDataAnalysis.

Applications: Exploratory Graphics of a Financial Dataset, Visualizing Functional Data withanApplication,eBay'sOnlineAuctions,VisualizationforGeneticNetworkReconstruction

List ofCourseSeminarTopics:
1.BringdatatolifewithSVG,CanvasandHTML.2.Pr
ogressive<svg>pie,donut,barandlinecharts
3.A   visualization
grammar.4.matplotlib: plotting with
Python5.PYthonsvgGrAphplottingLi
brary
6.Ageneralpurpose,real-
timevisualizationlibrary.7.Anobject-
orientedAPIforbusinessanalytics
8.AirpollutionvisualizationandforecastingplatformbasedonSpringCloud(
9.AtimevisualizationofkeywordsinTwitterwithPythonandtweepy,json,panda,andvincentlibrarie
s
10. Agriculture_Commodities_Prices_Seasons

ListofCourseGroupDiscussionTopics:
1.scanpy
2.Tools to Design or Visualize Architecture of Neural
Network3.Plexus-
InteractiveEmotionVisualizationbasedonSocialMedia4.Pre-
builtGrafanaXXL
5.Singlecellinteractiveplottingtools6.
Interactivewordcloud
7.Encoding   Data   with   Marks   and
Channels8.RenderingMarksandChannelswithD3.jsand
SVG9.IntroductiontoD3Scales
10.onlinedatavisualization

ListofHomeAssignments:
Design:
1.Aprogramforvisualising datafromaWhatAppchat.
2.RepositoryforthetidyNanopackagetoanalyzeandvisualizeNanoSight/NTAdata.3.Wra
ngling,Exploring,Analyzing,andVisualizingData
4.Visualizingdiscreteandcontinuousdataforknowngroups
5.GUI for displayingBinarySearchTreeswritteninC++usingtheQtLibrary.
Case Study:
1.Hubfordatavisualization&webcontentsusing JavaScriptdifferentchartlibrary2.Plexus -
InteractiveEmotionVisualizationbasedonSocialMedia
3.UsefulformakingplotsfromMEICA
4.Interactivecounty-levelmappingprojectfor UnitedStates
5.AcollectionofReactcomponentsforbuilding interactivedatavisualizations
Blog
1.Retrieving,Processing,andVisualizingDatawithPython
2.MetaOmGraph:a workbenchforinteractiveexploratory data analysisof largeexpressiondatasets
3.Map-of-emergency-incidents
4.AsmalldatavisualizationforAssemblyElectionresultsinvariousIndianstates5.GD
D Visualization
Surveys
1. isualiser foranalysingMachineLearning&featureengineering
2. googleMe3.Visualizin
gsurveydata
4.VisualizingRealTimedata5.
VisualisingBigdata

SuggestanassessmentScheme:
**SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand
checkifitcovers allaspectsofBloomsTaxonomy.**

MSE ESE GD SEMINAR HA VIVA LAB

Text Books:(AsperIEEEformat)

1. DataVisualizationwithPython:Createanimpactwithmeaningfuldatainsightsusinginterac
tiveand engagingvisuals,February2019,byMario Dobler,Packt Publishing

2. MasteringPythonDataVisualizationPaperback,October2015byKirthiRaman,PacktPublish
ing

ReferenceBooks:(AsperIEEEformat)

1. DataVisualization–APracticalIntroductionPaperback–Import,4Jan2019byKieranHealyChen,
2. Handbookofdatavisualization.SpringerScience&BusinessMedia.byChun-houh,WolfgangKarlHärdle,andAntonyUnwin,eds.

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1. Designandcreatedatavisualizations.
2. Performexploratorydataanalysisusingvisualization.
3. Evaluatevisualizationdesignalternatives.
4. Designandevaluatecolorpalettesforvisualization
5. Applydatatransformationssuchasaggregationandfilteringforvisualization.
6. Developavisualizationintensiveproject.

COattainmentlevels
Co1-2
Co2-3
Co3-4
Co4-3
Co5-4
Co6-4

FutureCoursesMapping:
Mentionothercoursesthat canbetakenaftercompletionofthiscourse
MS in data analytics and visualization

JobMapping:
WhataretheJob opportunitiesthat onecanget afterlearningthiscourse
Data visualization application developer, power BI developer-data visualization, data visualization engineer, data visualization engineer, data visualization expert, data analytics specialist-visualization, software development engineer-data visualization, data visualization designer, senior analyst-visualization

AI4007::InformationRetrieval

CoursePrerequisites: Datastructures,basicprogramming,basicprobabilityandstatistics

CourseObjectives:

1. Tostudybasicprinciplesandalgorithmsusedforinformationretrieval

2. Toanalyseretrievalmodelsandtheirretrievalfeedbackwithrespecttowebinformationmanagement

3. ToanalyseeffectivenessofgivenIRsystemby applyingvariousevaluation methods

4. Toapply indexingtechniquesand studytheireffectonperformanceofIRsystem

5. Tounderstandwebsearchingtechniquesandarchitectures

Credits:2   **TeachingSchemeTheory:2**Hours/Week

Course Relevance: This course provides an overviewof theimportant techniques with respectto the information retrieval system implementation. It emphasizes on the theory related to websearchengines.Evaluationandindexingtechniquesalsogiveinsightsintoissueswrtperformance. This course is very relevant for the advanced study or research in the related fieldssuchas naturallanguageprocessing(NLP).

SECTION-I

Topicsand Contents

InformationRetrievalIntroductionandModels: Introduction,AFormalDocumentRepresentation,ComponentsofaSearchEngine,CharacterizationofIRModels,Pre-processing, Porter'sStemmingAlgorithm, termweightingtechniques,Zipf'slaw,Heap'slaw

RetrievalModels: Overview   ofRetrievalModels oBooleanRetrieval,TheVectorSpaceModel,ProbabilisticModels,LatentSemanticIndexing,BayesianModel,InformationRetrieval as Classification, Relevance Models and Pseudo-Relevance, Feedback, ComplexQueries and Combining Evidence, Introduction to Lucene, Machine Learning and InformationRetrieval,LearningtoRank

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EvaluatingSearchEngines: Testcollections,Querylogs,EffectivenessMetrics,RecallandPrecision,Averagingandinterpolation,Focusingonthetopdocuments

Indexes:,FastInversion(FAST-INV)Algorithm,SignatureFiles,Partitioning,Tries,SuffixTreesandSuffixArrays,PATTree,DistributedIndexing,Index Compression

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SECTION-II

Topicsand Contents

QueriesandInterfaces: InformationNeedsandQueries,QueryProcessing,Structuredqueries,QueryTransformationandrefinement,StoppingandStemmingRevisited,SpellCheckingandQuerySuggestions,QueryExpansion,RelevanceFeedback,ContextandPersonalization,   Displaying   the Results, Result Pages and Snippets, Clustering the Results,Translation,User Behavior Analysis.

Ranking: Query Likelihood Ranking, Inverted Indexes, Document-at-a-time evaluation, Term-at-a-timeevaluation,Optimizationtechniques,Caching,TheBM25RankingAlgorithm

AcquiringData:CrawlingtheWeb,DocumentFeeds,DocumentConversion,DocumentStorage,DetectingDuplicates,NoiseDetectionandRemoval

Processing Text: Text Statistics, Document Parsing, Document Structure, Link extraction,Feature   and   Named   Entity   Extraction,   Social   Search, BeyondBagofWords,PageRankAlgorithm,HilltopAlgorithm

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List ofCourseSeminarTopics:
1. ParallelIR
2. DistributedIR
3. AGenericMultimediaIndexing(GEMINI)
4. Automatic imageannotationandretrieval
5. Audioretrievalalgorithms
6. Multimediasearchengine
7. Semanticsearchengine
8. Textsummarization
9. Cross-lingualsearchengine
10. SearchEngineSpamming

ListofCourseGroupDiscussionTopics:
1. QueryingStructuredandunstructuredData
2. Relevanceranking
3. Similarityofdocumentsmetric: whichoneto choose
4. Measuresoftheeffectivenessofan informationretrievalsystem
5. Similarity-basedretrievaltechniques
6. Linkanalysistechniques
7. Crawlingandnear-duplicatepages
8. Personalizedsearch
9. Collaborativefilteringapproaches
10. XMLindexingandsearch

ListofHomeAssignments:

Design:

1. Design a "person search engine". The search engine should automatically crawl and buildtextual representations of people that can be queried against. Example queries might includespecific names (e.g., "george bush"), job descriptions (e.g., "car company ceos"), facts aboutthe person(e.g.,"highestpaidfemalemusician"),etc.

2. Designasearchenginethatadaptstoimplicituserfeedback. Thisrequiresdevelopingauserinterfacethattracksvarioususerbehaviouralsignals(e.g.,clicks,dwell times,mousemovement, etc.) and uses that information to improve the quality of the ranking function overtime asmoreandmoreinformationbecomes available.

3. Designanalgorithmthatwillautomaticallysummarize,eachhour,themostwidelydiscussed topics on Twitter. The summary should be short (e.g., tweet-length) and provide anadequate summaryofthetopic.

4. Design a tool that will automatically associate images with news articles. More specifically,given the text of a news article, the task is to automatically identify a single relevant that couldbe placed alongside the article. For example, for a news article about the positive effects ofgreen tea, relevant images would include tea leaves, cups of tea, health related symbols/logos,etc.

5. Design a cross-lingual search engine. For example, use Wikipedia as a source of parallelcorpora.

Case Study:

1. Lucene
2. PatternMatchingtechniques
3. LatentSemanticIndexing

4. Learning-basedrankingalgorithms
5. Classicalevaluationmetrics

Blog

1. IndexcreationforIRsystem:InvertedFiles
2. IndexcreationforIRsystem:SignatureFiles
3. IndexcreationforIRsystem:SuffixTreesandSuffixArrays
4. Developmentofsemanticsearchenginetodealwithpolysemy,synonymyissuesoftextdocuments
5. Developmentoftextsearchengine

Surveys

1. Crawlingandnear-duplicatepages
2. Content-based filtering
3. Unifiedfiltering
4. Topicdetectionandtracking
5. Crosslanguage informationretrieval

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentandcheckifitcovers allaspectsofBloomsTaxonomy.

MSE,ESE,GD,Seminar,HA

Text Books:(AsperIEEEformat)

1."*ModernInformationRetrievalTheConceptsandTechnologybehindSearch*",*RicardoBaeza-Yates,BerthierRibeiro-Neto,PearsonEducation:NewDelhi,2007*

2. "IntroductiontoInformationRetrieval",ChristopherD.Manning,PrabhakarRaghavanandHinrichSchütze,CambridgeUniversityPress,2012

ReferenceBooks:(AsperIEEEformat)

1."*Information Storage and Retrieval Systems Theory and Implementation*", *Gerald Kowalski,Mark Maybury,SpringerPvt.Ltd.,2006*
2. "InformationRetrievalDataStructures&Algorithms"WilliamFrakes,RicardoBaeza-Yates,PearsonEducation,2008

3.*"InformationRetrieval",C.J.VanRijsbergen,InformationRetrievalGroup,UniversityofGlasgow,onlineat http://www.dcs.gla.ac.uk/Keith/Preface.html*

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1. Explainbasicprinciplesofinformationretrievalsystems
2. Describevarious informationretrievalsystemarchitecturesandmodels
3. Validateretrievalperformanceofan informationretrievalsystem
4. Constructvariousindexesusingsuitabletechniques
5. Understandhowqueriesareprocessed
6. Learntoolsandtechniquesusefulincutting-edgeresearchintheareaofinformationretrieval

COattainmentlevels
Co1-1
Co2-2
Co3-3
Co4-4
Co5-3
Co6-4

FutureCoursesMapping:
 AdvancedIR

JobMapping:
Sr. Software Engineer, Data Engineer, Data Analyst / Statistical Analyst, Search Lead, Data(orMachineLearning)Scientist

FFNo.:654

AI4008::AugmentedRealityandVirtualReality

CoursePrerequisites:ComputerGraphics

CourseObjectives:

1. LearningdifferentcomponentsofAugmentedandVirtualRealitySystems
2. UnderstandingVRmodeldevelopment
3. UnderstandingARmodeldevelopment
4. IntegratingdifferentsensorswithAR/VRsystems
5. UnderstandingdifferentapplicationsofAR-VR

Credits:2   **TeachingSchemeTheory:2**Hours/Week

CourseRelevance: Thissubjectisimportantinalldomainstoimplementsimulationorprototypeofdifferentsystems.

SECTION-I

Topicsand Contents

3D User Interface:Input device characteristics, Desktop input devices, Tracking Devices, 3DMice, Special Purpose Input Devices,Direct Human Input, Home-Brewed Input Devices,ChoosingInputDevices for 3DInterfaces.
SoftwareTechnologies:Database-WorldSpace,WorldCoordinate,WorldEnvironment,Objects-Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and otherattributes, Virtual Reality, VR Environment-VR Database, Tessellated Data, LODs, Cullersand Occluders, Lights and Cameras, Scripts, Interaction-Simple, Feedback, Graphical UserInterface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions,World AuthoringandPlayback,VRtoolkits,Available software in the market

SECTION-II

TopicsandContents

AugmentedandMixed Reality, Taxonomy,technologyand featuresofaugmentedreality,difference between AR and VR, Challenges with AR, AR systems and functionality, Augmentedrealitymethods,visualizationtechniquesforaugmentedreality,wirelessdisplaysineducational augmented reality applications, mobile projection interfaces, marker-less trackingforaugmentedreality,enhancing interactivityinARenvironments,evaluatingARsystems.

List ofCourseSeminarTopics:
1. 3Dobjectcreation
2. Cameraprojections
3. Geometrictransformations
4. Viewingtransformations
5. C#scriptgraphicsrendering
6. C#scriptinterfaceforUnitysoftware
7. ObjectorderrenderinginUnitysoftware
8. Object tracking
9. Motionperception
10. Rasterizationandpixelshading

ListofCourseGroupDiscussionTopics:
1. VirtualVsAugmentedreality
2. VirtualVsAugmented Vs.Mixedreality
3. Diminishedreality
4. Mediatedreality
5. Vuforia
6. Markerbased AR
7. Markerlesstracking
8. Euler rotationtheoremand axis-anglerotation
9. Quaternion
10. Visualanddepthperception

ListofHomeAssignments:D
esign:
  1. Solarmodel
  2. Librarymodel
  3. Classroommodel
  4. Carshowroommodel
  5. Livingroommodel

Case Study:
  1. RaytracinginUnity
  2. PixelshadinginUnity
  3. DistortionshadinginUnity
  4. ImageorderrenderinginUnity
  5. PoseestimationinAR

Blog
  1. AR/VRmodelsforKids
  2. AR/VRmodelstostudymachinedesign
  3. AR/VR modelstostudynetworking
  4. AR/VRmodelsforspaceresearch
  5. AR/VRmodelsforwearingdevices

Surveys
  1. Imageprocessing forVR/AR
  2. ProjectionsinVR/AR
  3. LighteffectinVR/AR
  4. TexturemappinginAR/VR
  5. ShadowingtechniqueinAR/VR

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand
checkifitcovers allaspectsofBloomsTaxonomy.
HA   Seminar   GD   MSE   ESE   LAB   VIVA

Text Books:(AsperIEEEformat)

1.   AlanBCraig,WilliamRShermanandJeffreyDWill,DevelopingVirtualRealityApplications:Foundations
ofEffective Design, MorganKaufmann,2009.
2. *GerardJounghyunKim, DesigningVirtualSystems:TheStructuredApproach, 2005.*

ReferenceBooks:(AsperIEEEformat)

1. GrigoreC.Burdea,PhilippeCoiffet,VirtualRealityTechnology, Wiley2016

2. DieterSchmalstiegandTobiasHöllerer,AugmentedReality:Principles&Practice,PearsonEducationIndia,2016

3. KentNorman(Ed),WileyHandbookofHumanComputerInteraction,Wiley2017

4. AndyField, "DiscoveringStatisticsUsingSPSS",SAGE PublicationsLtd.,2009

MoocsLinksandadditionalreadingmaterial:
www.nptelvideos.in

CourseOutcomes:
1. LearnAR-VRgraphicsobjectcreation
2. DesignobjectsinAR-VRenvironment
3. Developrenderingalgorithms
4. Understandmodellingandviewingtransformations
5. Applyvariousrealityeffectslikelighting, texturemappingetc.
6. Developdifferent modelling,gamingapplications

COattainmentlevels
Co1-1
Co2-2
Co3-3
Co4-3
Co5-4
Co6-4

FutureCoursesMapping:
3D modelling

JobMapping:
WhataretheJob opportunitiesthat onecan getafterlearningthiscourseGame developers,graphicsdesigner,Game architect,

FFNo.:654

AI4009::InternetOfThings

CoursePrerequisites:ComputerNetworks,ComputerProgrammingC

ourse Objectives:

1. UnderstandtheIOTTerminologyandTechnology

2. DescribeintelligentIOTsystems.

3. AnalyzeProtocolstandardizationfor IOT

4. PerformananalysisofIOT securityissuesusingAItechnology.

5. IdentifytheroleofcloudcomputinginIOT.

Credits:4   **TeachingSchemeTheory:3**Hours/Week

Lab:2 Hours/Week

Course Relevance: IoT or Internet of Things is primarily a full system of all the interconnectedcomputing devices, having all the mechanical and digital machines.The Internet of Things

isgettingsmarter.Companiesareincorporatingartificialintelligenceinparticular,machinelearning into their IoT applications. Vendors of IoT platforms—Amazon, GE, IBM, Microsoft,Oracle, PTC, and Sales force are integrating AI capabilities IoT is beneficial because itmakesour work easy and is very less time-consuming.IoT has got a lot more scope in terms of making acareerandevenexploringmoreopportunitiesifstartingup withtheirownbusiness.

SECTION-I
Topicsand Contents **Introduction to Internet of Things –** Definition & Characteristics, Importance of IoT, PhysicalDesign of IOT, Logical Design of IOT, IOT Enabling technologies, IOT Levels & DeploymentTemplates, IoT and M2M, The role of Artificial Intelligence in IOT, Introduction to AIOT,Applications ofArtificialIntelligenceinInternetofThings:CollaborativeRobots,DigitalTwins,Drones,SmartRet ailing,SmartCities,SmartHealth,etc. **AI and the Internet of Thing: Real World Use-Cases:** Automated vacuum cleaners, like that ofthe iRobotRoomba,Smartthermostatsolutions,like thatofNestLabs **Design Methodology –** Purpose & Requirements Specification, Process Specification, DomainModelSpecification,InformationmodelSpecification,Servicespecification,IOTlevelSpeci fications,FunctionalView   Specifications,   OperationalView   Specification,device andcomponentintegration,applicationdevelopment,EmbeddedsuiteforIoTPhysicaldevice–

Arduino/RaspberryPiInterfaces

SECTION-II

Topicsand Contents

ConnectivityTechnologiesandCommunicationProtocolsinIOT:RFID:Introduction,Principleo fRFID,Components ofanRFIDsystem,RFIDProtocols&NFC protocols,Wireless SensorNetworks:WSNArchitecture,thenode,connectingnodes,NetworkingNodes,SecuringCom municationWSNspecificIoTapplications,**ProtocolsinIOT:**CoAP,XMPP,AMQP,MQTT,
Internetofthings Challenges: VulnerabilitiesofIoT,Security,Privacy& Trustfor IoT,Security requirements Threat analysis, Use cases and misuse cases, Introduction to cloudcomputing,RoleofCloudComputinginIoT,Cloud-to-
DeviceConnectivity,Clouddatamanagement,clouddatamonitoring,ClouddataExchange,ENHAN CINGRISKMANAGEMENTbypairingIoTwithAI

List ofCourseSeminarTopics:
1. Self-drivingvehicles
2. Securityand accessdevices
3. AI-poweredIoT
4. RoleofAIandIOTinHealthandMedicine
5. RPioperatingsystemfeaturesoverArduino
6. Arduinoarchitectureanditsinterfacingtechniques
7. IPv6technologies fortheIoT.
8. SensorsinIOT
9. IoTSystemManagement
10. AutomatedCommuteandTransport

ListofCourseGroupDiscussionTopics:
1. FutureofIOT:AI
2. THEAIKEYTOUNLOCKIoTPOTENTIAL
3. IOTProtocols
4. WSNarchitecture
5. RoleofcloudcomputinginIOT
6. ChallengeinintegrationofIoTwithCloud.
7. RFIDVsNFCwithrealworldexample
8. VulnerabilitiesofIoT
9. Cloudtypes;IaaS,PaaS,SaaSwithrealworldexample
10. ResourceManagementInTheInternet OfThings

ListofHomeAssignments:
Design:
1. DesignacompleteIOTarchitectureforSmartofficebasedonAItechnique
2. DesignacompleteIOTarchitectureforSmartgardenbasedonAItechnique
3. DesignacompleteIOTarchitectureforSmartindustrybasedonAI technique
4. ProvideacompletelayeredarchitectureforWeathermonitoringsystemandexplainthesame
5. DeveloptheIOTsecuritysystemfortheapplications,justtomakesurethatthedataiscollectedsafely andsound

Case Study:
1. SmartRetail
2. FleetManagementandAutonomousVehicles
3. SmartEnergy
4. SmartCampus
5. ClassroomMonitoringSystem

Blog
1. DroneTrafficMonitoring
2. IntelligentRouting
3. RevolutionizingIoTThroughAI
4. InternetofBusiness
5. AIinIOTforHealthcare

Surveys
1. PredictiveEquipmentMaintenanceinIndustries
2. SmartAgriculture
3. RuralDevelopmentusingIOT
4. Tesla'sAutopilot
5. SmartTransportation

SuggestanassessmentScheme:
SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentand checkifitcoversallaspectsofBloomsTaxonomy.
MSE ESE CourseProject GD/PPT

Text Books:(AsperIEEEformat)

1.ArshdeepBahga,VijayMadisetti,"Internetof   Things–Ahands-onapproach",UniversitiesPress,2015
2 Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies forSmart Environments and Integrated Ecosystems", River Publishers, ISBN-10: 87929827353JanHoller,VlasiosTsiatsis,CatherineMulligan,StefanAvesand,StamatisKarnous kos,
DavidBoyle,"FromMachine-to-MachinetotheInternetofThings:Introductionto aNewAgeofIntelligence",1stEdition,AcademicPress,2014.
4FrancisdaCosta,"RethinkingtheInternetofThings:AScalableApproachtoConnectingEverything", 1stEdition,ApressPublications,2013

ReferenceBooks:(AsperIEEEformat)

*1.*Pethuru Raj, Anupama C. Raman, The Internet of Things Enabling Technologies, Platforms,and Use Cases, CRC Press Taylor & Francis Group, International Standard Book Number-13:978-1-4987-6128-4
 2. Rajkumar Buyya, Amir Vahid Dastjerdi Internet of Things – Principals and Paradigms,Morgan Kaufmann is an imprint of Elsevier, ISBN: 978-0-12-805395-9 HakimaChaouchi, "The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, WillyPublications
3. OlivierHersent,DavidBoswarthick,OmarElloumi,TheInternetofThings:KeyApplicationsand Protocols,ISBN:978-1-119-99435-0,2ndEdition,WillyPublications
4. Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things",.Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13:978-0989973700.

MoocsLinksandadditionalreadingmaterial:
1.https://nptel.ac.in/courses/106/105/106105166/
2.https://swayam.gov.in/nd1_noc19_cs65/preview

CourseOutcomes:

Upon thecompletion ofthecourse,student willbeableto

1. Designanapplicationbased onIOTTerminologyandTechnology
2. DifferentiatetheroleofAIinIOTintermsofAIOT.
3. ImplementtheconnectivitytechnologiesandprotocolsinIOT
4. Produceasolutionfor IOTsecuritychallengesusingtheconceptofAI.
5. ApplyCloudtechnologyconcepts for developingIOTbasedprototype
6. PerformprogramminganddataanalysistobuildandtestacompleteworkingIntelligenceIoTsystem.

COattainmentlevels

Co1-
2Co2-
1Co3-
3Co4-
4Co5-
4Co6-
5

FutureCoursesMapping:

KnowledgeofIOTcanbeappliedforthe developmentofapplications basedonAIorML

JobMapping:

1. IOTdeveloper
2. IOTEmbeddedsoftwaredeveloper
3. Cloud Engineer
4. NetworkEngineer
5. Agriculture(E-Market,LivestockTraceability,AgricultureDronesetc)
6. WarehouseManagers
7. SmartPathology
8. Canlaunchstartupbusiness

AI4010: Predictive Analytics

CoursePrerequisites: Descriptive statistics, Probability Distribution, Hypothesis testing

CourseObjectives:

1. To learn, how to develop models to predict categorical and continuous outcomes.

2. Usage of techniques such as neural networks, decision trees, logistic regression, support vectormachines and Bayesian network models.

3. To know the use of the binary classifier and numeric predictor nodes.

4. To get familiarity on automation of modelselection.

5. To advice on when and how to use each model.

6. To learn how to combine two or moremodels to improve prediction performance.

Credits:2   **TeachingSchemeTheory:2Hours/Week**

CourseRelevance: Thiscourseiswidelyapplicableto   all   types   ofindustriesfor   improving productivityandquality.

SECTION-I

Topicsand Contents

Introduction to Data Mining Introduction, what is Data Mining? Concepts of Data mining, Technologies Used, Data Mining Process, KDD Process Model, CRISP – DM, Mining on various kinds of data, Applications of Data Mining, Challenges of Data Mining.

Data Understanding and Preparation Introduction, Reading data from various sources, Data visualization, Distributions and summary statistics, Relationships among variables, Extent of Missing Data. Segmentation, Outlier detection, Automated Data Preparation, Combining data files, Aggregate Data, Duplicate Removal, Sampling DATA, Data Caching, Partitioning data, Missing Values.

<table>
<tr><td></td></tr>
<tr><td><h2 style="text-align:center">SECTION-II</h2></td></tr>
<tr><td>

Topicsand Contents

Model development & techniques Data Partitioning, Model selection, Model
Development Techniques, Neural networks, Decision trees, Logistic regression,
Discriminantanalysis, Support vector machine, Bayesian Networks, Linear Regression, Cox
Regression,Association rules.

Model Evaluation and Deployment Introduction, Model Validation, Rule Induction
Using CHAID, Automating Models for Categorical and Continuous targets, Comparing and
Combining Models, Evaluation Charts for Model Comparison, MetaLevel Modeling,
Deploying Model, Assessing Model Performance, Updating a Model.

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List ofCourseSeminarTopics:
1. Handling missing values
2. Handling outliers in data.
3. Principle Component Analysis.
4. Cross Validation.
5. Variable Importance.
6. Dealing with Nominal Predictors
7. Sampling Techniques.
8. Confusion Matrix
9. Predictive inference
10. Time series forcasting

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ListofCourseGroupDiscussionTopics:
1. Bias Variance Tradeoff
2. Explain vs Predict
3. Classification vs Regression
4. Single model vs Ensemble model
5. Supervised vs Unsupervised approaches.
6. Accuracy vs explainability
7. Performance evaluation of classifier vs Performance evaluation of Regressor
8. Auto-regressive and moving average models.
9. Additive & Multiplicative models.
10.   SEMMA (SAS) and CRISP (IBM)

ListofHomeAssignments:

Design:
1. Design a classifier for real world application.
   2. Design a regression model for real world application.
   3. Design s voting-based ensemble model for real world application.
   4. Design a time series forecasting model.
   5. Design s stacked ensemble model for real world application.

Case Study:
1. WriteacasestudyongoalprogrammingforanITstartupcompany using predictive analytics tools.
   2. Casestudyonprojectcrashingofasoftwaredevelopmentcompany using predictive maintenance tools.
3. Writeacasestudyon efficient projectmanagement by utilizing predictive maintenance tools.
   4. Writeacasestudytoimproveasale of a manufacturing company using predictive analytics.
   5. Writeacasestudyonclassificationofinventory.

Blog
1. Write a blog on data summaries.
2. Write a blog on data visualization.
3. Write a blog on data preprocessing.
4. Write a blog on model evaluation and comparison of models.
5. Write a blog on dimensionality reduction techniques.

Surveys:
1. Takethe surveyofapplicationsofpredictive analytics in banking sector.
2. Takethesurveyofdifferentmodel deployment techniques.
3. Takesurveyinventoryclassificationmodels using datamining techniques.
4. Takethe surveyofoptimizationtechniquesindatascience.
5. Take a survey on time series forecasting.

SuggestanassessmentScheme:

SuggestanAssessmentschemethatisbestsuitedforthecourse.Ensure360degreeassessmentandcheckifitcovers allaspects ofBloomsTaxonomy.
MSE   ESE   PPT   GD   VIVA HA

Text Books:(AsperIEEEformat)

1. *"An Introduction to Statistical Learning: with Applications in R" by James, Witten, Hastie and Tibshirani, Springer, 1st. Edition, 2013.*
2. *Regression Modeling with Actuarial and Financial Applications, Edward W. Frees, 2010, New York: Cambridge. ISBN: 978-0521135962.*
3. *E.Alpaydin, Introduction to Machine Learning, Prentice Hall Of India,2010*

ReferenceBooks:(AsperIEEEformat)
1. *ASM Study Manual for SRM- Statistics for Risk Modeling | 2nd Edition, Weishaus | ASM. ISBN: 978-1-64756-065-2*
2. *Trevor Hastie, Robert Tibshirani, Jerome Friedman , The Elements of Statistical Learning-Data Mining, Inference, and Prediction ,Second Edition , Springer Verlag, 2009.*

MoocsLinksandadditionalreadingmaterial:
1. http://faculty.smu.edu/tfomby/
2. http://www-bcf.usc.edu/~gareth/ISL/

CourseOutcomes:
Thestudentwillbeableto–

1. Understand the process of formulating business objectives
2. Study data selection/collection, preparation and process.
3. To successfully design, build, evaluate and implement predictive models for a various business application.
4. Compare the underlying predictive modeling techniques.
5. Select appropriate predictive modeling approaches to identify cases to progress with.
6. Apply predictive modeling approaches using a suitable packages.

COattainmentlevels   CO1-3   CO2- 3   CO3-4   CO4-4   CO5-5   CO6-5
FutureCoursesMapping: MS in Data Science, MS in Machine Learning
JobMapping: ResearchAnalyst,Projectmanager, Data Scientist

AI4011:Data Management, Protection andGovernance

Course Prerequisites: Database Management System, Operating System

Course Objectives:

To facilitate the learner to –
1. Get acquainted with the high-level phases of data life cycle management.
2. Acquire knowledge about the various aspects of data storage, data availability,
data protection.
3. Gain exposure to various solutions/reference architectures for various use-cases.AI

4. Understand the technical capabilities and business benefits of data protection.

Credits: 2   **Teaching Scheme   Theory:2 Hours/Week**

Course Relevance: Since technology trends such as Machine Learning , Data science and AI rely on data quality, and with the push of digital transformation initiatives across the globe, data management, governance and security is very much important.

SECTION-I

Data Storage, Availability and Security

Introduction to data life cycle management (DLM): - Goals of data life cycle management,Challenges involved: Volume of data source, Ubiquity of data locations, User demand for access;Stages of data life cycle - creation, storage, usage, archival, destruction;Risks involved without DLM, benefits, best practices.

Data storage and data availability :- Storage technology: Hard Disk Device (HDD), Solid State Devices (SSD), memory devices, Data access - block, files, object ; Data center End to End View – overview of complete stack including storage, network, host, cluster, applications, virtual machines, cloud storage ; Storage virtualization technologies - RAID level, storage pooling, storage provisioning ; Advance topics in storage virtualization – storage provisioning, thin provisioning; Cloud storage – S3, glacier, storage tiering; High Availability: Introduction to high availability, clustering, failover, parallel access

Data Threats and Data center security: - Type of Threats: Denial of Service (DoS), man in the middle attacks, Unintentional data loss,Repudiation,Malicious attacks to steal data; Introduction to Ransomware; Understanding, Identification and Threat modelling tools ;Security: Authorization and authentication - access control, Transport Layer

Security (TLS), key management, security in cloud, Design and architecture considerations for security

SECTION-II

Data Protection, Regulation and Governance

Introduction to data protection: - Introduction- Need for data protection,basic of back-up/restore;Snapshots for data protection, copy-data management (cloning, DevOps);De-duplication;Replication;Long Term Retention – LTR;Archival;Design considerations: System recovery, Solution architecture,Backup v/s Archival,media considerations and management (tapes, disks, cloud), challenges with new edge technology (cloud, containers)

Data regulation, compliance and governance: - Regulations requirements and Privacy Regulations: The Health Insurance Portability and Privacy Act of 1996 (HIPPA), PII (Personally Identifiable Information), General Data Protection Regulation (GDPR) ;Information Governance : Auditing, Legal Hold,Data classification and tagging (Natural Language Processing); India's Personal Data Protection bill

Applications uninterrupted: - Understand data management aspects of traditional and new edge applications;Reference architecture/best practices (pick 2-3 case studies from below topics): Transactional Databases (Oracle, MySQL, DB2), NoSQL Databases (MongoDB, Cassandra),Distributed applications (micro service architectures),Cloud applications – Platform as Service (PaaS), Software as Service (SaaS), Kubernetes,Multi-Tiered applications,ETL workloads,Data analytics (AI/ML)

List of Home Assignments:

Design:

1. Design data management aspects for cloud applications.

2. Design data management aspect for MongoDB/Cassandra.

3. Design data management aspect Distributed applications.

4. Design data life cycle management for any application.

5. Design data management for any Multi-Tiered application.

Case Study:

1. Consider different Transactional and NoSQL Data bases. Comparative study.

2. Compare various cloud applications based on Platform as service and Software as service.

3. Data Analytics based study for data management.

4. Study of Multi-Tiered Applications

5. Study data management in DevOps

Blog:

1. Comparative study of data protection schemes.

2. study of The Health Insurance Portability and Privacy Act of 1996 (HIPPA)

3. Need of data management, protection and governance

4. How Threat modelling tools are useful? Consider any application related to it.

5. Role of storage Technology for cloud storage.

Surveys:

1. Survey on data protection challenges with new edge technology like cloud
2. Survey on General Data Protection Regulation (GDPR)
3. Survey on Data classification and tagging in Natural Language Processing
4. Survey on Ransomware data security.
5. Survey on Kubernetes.

Suggest an assessment Scheme:

MSE, ESE, HA

Text Books: (As per IEEE format)

1. Robert Spalding, 'Storage Networks: The complete Reference'.
2. Vic (J.R.) Winkler, 'Securing The Cloud: Cloud Computing Security Techniques and Tactics',
Syngress/Elsevier - 978-1-59749-592-9

Reference Books: (As per IEEE format)

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1. Martin Kleppmann, 'Designing Data-Intensive Applications' , O'Reilly

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Web References:
1. https://www.enterprisestorageforum.com/storage-hardware/storage-virtualization.html
2. https://searchstorage.techtarget.com/definition/data-life-cycle-management
3. https://www.hitechnectar.com/blogs/three-goals-data-lifecycle-management/
4. https://www.bmc.com/blogs/data-lifecycle-management/
5. https://www.dataworks.ie/5-stages-in-the-data-management-lifecycle-process/
6. https://medium.com/jagoanhosting/what-is-data-lifecycle-management-and-what-phaseswould- it-pass-through-94dbd207ff54
7. https://www.spirion.com/data-lifecycle-management/
8. https://www.bloomberg.com/professional/blog/7-phases-of-a-data-life-cycle/
9. https://www.datacore.com/storage-virtualization/
10. https://www.veritas.com/content/dam/Veritas/docs/solutionoverviews/
11. V0907_SB_InfoScale-Software-Defined-Infrastructure.pdf
12. https://www.veritas.com/solution/digital-compliance
13. https://www.veritas.com/solution/data-protection
14. https://www.veritas.com/gdpr

Course Outcome:

By taking this course, the learner will be able to –
1. Understand the data management world, challenges and best practices.
2. Compare various concepts and technologies for enabling data storage and high availability.
3. Illustrate various types of data threats and approaches to ensure data center security.
4. Explain the various concepts related to data protection.
5. Outline different standards for compliance and governance of data.
6. Understand various approaches for designing data intensive enterprise

applications and industry standard solutions in data management.

CO PO Map:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2														
CO2			2													
CO3					3											
CO4						2										
CO5										1						
CO6														3		

CO attainment levels:

CO	CO1	CO2	CO3	CO4	CO5	CO6
Val	1	2	3	4	2	3

Future Courses Mapping: Following courses can be learned after successful completion of this course: Cloud storage security, Data management in Distributed system, Data Analytics

Job Mapping: Manager- Master Data Governance, Data Analyst, Data Strategist, Solution and Data Governance Architect

AI4012:Reinforcement learning

Course Prerequisites: Proficiency in Python, Calculus, Linear Algebra, Basic Probability and Statistics, Foundations of Machine Learning

Course Objectives:

1. To pursue basic knowledge of reinforcement learning techniques.
2. To understand foundation Techniques of Deep Reinforcement Learning.
3. To inculcate dynamic programming techniques.
4. To provide a clear and simple account of the key ideas and algorithms of reinforcement learning.
5. To explore how the learning is valuable to achieve goals in the real world.
6. To explore about how Reinforcement learning algorithms perform better and better in more ambiguous, real-life environments while choosing from an arbitrary number of possible actions.

Credits:2   **Teaching Scheme Theory: 2** Hours/Week

Course Relevance: Reinforcement learning (RL) refers to a collection of machine learning techniques which solve sequential decision-making problems using a process of trial-and-error. It is a core area of research in artificial intelligence and machine learning, and today provides one of the most powerful approaches to solving decision problems.

SECTION-1

The Reinforcement Learning Problem: Reinforcement Learning, Examples, Elements of Reinforcement Learning, Limitations and Scope
Finite Markov Decision Processes: The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation
Dynamic Programming: Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming
Model-free solution techniques: Temporal difference learning, Monte Carlo Methods, Efficient Exploration and value updating

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SECTION-1I

Topics and Contents

Batch Reinforcement Learning: Introduction, Batch Reinforcement Learning Problem, Foundations of Batch RL Algorithms, Batch RL Algorithms, Batch RL in Practice
Learning and Using Model: What is Model, Planning: Monte Carlo Methods, Combining Models and Planning, Sample Complexity, Factored Domains, Exploration, Continuous Domains, Empirical Comparisons, Scaling Up
Planning and Learning with Tabular Methods: Models and Planning, Integrating Planning, Acting, and Learning, When the Model Is Wrong, Prioritized Sweeping, Full vs. Sample Backups, Trajectory Sampling, Heuristic Search, Monte Carlo Tree Search

List of Course Seminar Topics:
1. Naive REINFORCE algorithm
2.TD Control methods - SARSA
3.Probability Primer
4.Bellman Optimality
5.Imitation learning
  6.Sequential Decision-Making
7.Michael Littman: The Reward Hypothesis
8.multi-agent learning
9.An n-Armed Bandit Problem
10.Q-Learning

List of Course Group Discussion Topics:
1.Human Intelligence versus machine intelligence
2.Security and Privacy in Pervasive Network
3. Security of Smart devices
4.Future of Ubiquitous Computing
5.Online Least-Square Policy Iteration
6. Gradient-Descent Methods
7. Bellman Optimality
8. Reward Shaping
9. Hierarchical RL
10. Atari Reinforcement Learning Agent

List of Home Assignments:
Design:
1. Smart personal health assistant
2. Human activities sensor
3. Intelligent buildings
4. Data storage searching in IOT
5. Protocols in IOT

Case Study:
1. Challenges in age of Ubiquitous computing
2. Ethnography in Ubiquitous computing
3. Cyber Physical System
4. Approaches to Determining Location Ubiquitous computing
5. Q-Learning for Autonomous Taxi Environment

Blog
1. Smart Devices for smart life
2. Mobile affective computing
3. IOT and Cloud Computing
4. Deep Q-Learning for Flappy Bird
5. Q-Learning for any game

Surveys
1. Data Collection for Ubiquitous computing Field
2. Usage of smart devices in daily life style
3. Video Summarization
4. Behaviour Suite for Reinforcement Learning
5. Causal Discovery with Reinforcement Learning

Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360-degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE   ESE   PPT   GD   VIVA HA

Text Books: (As per IEEE format)

1. Ed. John Krumm; Ubiquitous Computing Fundamentals; Chapman & Hall/CRC 2009
2. Richard S. Sutton and Andrew G. Barto, Reinforcement learning: An introduction, Second Edition, MIT Press, 2019

Reference Books: (As per IEEE format)

1. Wiering, Marco, and Martijn Van Otterlo. Reinforcement learning. Adaptation, learning, and optimization 12 (2012)
2. Mohammad S. Obaidat and et al; Pervasive Computing and Networking, Wiley

Moocs Links and additional reading material:www.nptelvideos.in

Course Outcomes:
The students should be able to
1)Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning
2) Formalize problems as Markov Decision Processes
3) Understand basic exploration methods and the exploration / exploitation trade-off
4) Understand value functions, as a general-purpose tool for optimal decision-making
5) Implement dynamic programming as an efficient solution approach to a real-world problem
6) Explain various tabular solution methods.

COattainmentlevels
CO1-3
CO2-3
CO3-4
CO4-4
CO5-5
CO6-5

FutureCoursesMapping:

MS in Artificial Intelligence & Machine Learning, Masters in digital transformations

JobMapping:

Reinforcement learning expert, ResearchAnalyst,researchengineer(reinforcement learning), data scientist (reinforcement learning), Reinforcement learning engineer.