# Ph.D. Computer Engineering JULY 2018

## CODE: PHDCE-17-03

### SUBJECT NAME: ADVANCED INFORMATION RETRIEVAL SYSTEMS

### NO OF CREDITS: 4

| | | | |
|---|---|---|---|
| | | SESSIONAL: | 25 |
| L | P | THEORY EXAM: | 75 |
| 4 | 0 | TOTAL: | 100 |

NOTE: Question paper has two parts. Part-1 has 10 questions each of 2 marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

**Course Objectives:**

1. To build an understanding of the fundamental concepts of Information Retrieval
2. To familiarize students with the basic taxonomy of Indices and Laws for estimation and modeling distribution of terms
3. To understand definition of Search, Integration & Web Data Mining
4. To introduce the concept of Semantic Web and related problems
5. To understand RDF : basic elements capabilities and rules
6. To learn the elements of Swoogle, SWDs and indexing
7. To understand the bisics of FOAF, its vocabulary and Semantic Markup
8. To learn Semantic Web Search Engine, Query Processing and Indexing

**MODULE-1 : INTRODUCTION TO ADVANCED INFORMATION RETRIEVAL SYSTEM**

Information retrieval problem, an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval, Basic Index Construction & Index Compression- an inverted index, Bi-word indexes, Positional indexes, Combination schemes, Heaps Law & Zipf's law, Advanced Indexing & Retrieval Schemes, Better Link Analysis for ranking, Advantages of Advanced IRS over Basic IRS

**MODULE-2: THE WORLD OF SEMANTIC WEB**

Introduction to WWW and definition of Search, Integration & Web Data Mining. Semantic Web and Introduction to metadata, its basic concepts and considerations. Search Engines for traditional web: Building the index table, conducting the search, Search Engines for Semantic Web: Building a semantic Web Search Engines, Using the Semantic Web Search Engines Problems related to Semantic Web Search Engines

**MODULE-3: THE BASIC ELEMENTS OF SEMANTIC WEB**

Building block of Semantic Web: RDF, Overview of RDF, Basic elements of RDF, RDF Triples, Basic syntax, literal values and other RDF capabilities. Fundamental rules of RDF,

Aggregation & Distributed Information RDFS, Taxanomy and Ontology, Core Elements of RDFS, Syntax & Examples, Concepts of Ontology & Taxonomy.

**MODULE-4: THE SEMANTIC WEB: REAL –WORLD EXAMPLES**

Swoogle: A Search Engine for Semantic Web documents. Swoogle Architecture, Discovery of SWDs, Collection of Metadata and calculation of rankings using metadata. Indexation and retrieval of SWDs . FOAF: Friend of a Friend, Basic FOAF Vocabulary & Examples. Creating a FOAF Document and getting into the Circle. Semantic Markup, Semantic Markup issues.

**MODULE-5: SEMANTIC WEB SEARCH ENGINES REVISITED:**

Why Search Engines Again? Why traditional Search /engines fails? The Design of Semantic Web Search Engine prototype: Query processing, Discovery Strategy, Indexation Strategy, Using the prototype system.Why this prototype Search Engine provides better performance.

**Course Outcomes:**

a. The students will be able to understand basic Information Retrieval Systems.
b. The students will be able to identify the different types of indices and will be able to make estimations and model distribution of terms.
c. The students will be able to understand the concept of Semantic Web Search Engine and related issues.
d. The students will be able to learn RDF, RDF triples , syntax, Aggregation and Distributed Information.
e. The students will be able to understand the core elements of Swoogle, its architecture and retrieval of SWDs
f. The students will be able to understand the basic concept of FOAF, creating FOAF document and Semantic Markup issues
g. The students will be able to understand the design of the Semantic Web Search Engine
h. The students will be able to learn the discovery strategy and indexation strategy.

**CODE: PHDCE-18-01**

**SUBJECT NAME: ADVANCED INTERNET OF THINGS**

**NO OF CREDITS: 3**

| | | | | |
|---|---|---|---|---|
| | | | SESSIONAL: | 25 |
| L | T | P | THEORY EXAM: | 75 |
| 3 | 0 | 0 | TOTAL : | 100 |

**Pre-requisites:** Internet and web Technology, Computer Networks

**Course Objectives:**

1. Student will be able to learn the basics of IOT.
2. Student will be able to analyse basic protocols of wireless and MAC.
3. Students will get basic knowledge of resource management.

**MODULE-1: INTRODUCTION TO IoT**

Introduction to IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs ,IoT & M2M Machine to Machine, Difference between IoT and M2M, Software define Network, Challenges in IoT(Design ,Development, Security).

**MODULE-2: COMMUNICATION PROTOCOL AND SENSOR NETWORK**

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Protocols for machine to machine communication, Sensor deployment & Node discovery, Data aggregation & dissemination.

**MODULE-3: RESOURCE MANAGEMENT IN IOT**

Interoperability in IoT, Domain specific applications of IoT, Home automation, Industry applications, Surveillance applications, Other IoT applications Clustering, Synchronization, Software agents.

**MODULE-4:**

Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications, Recent research paper studies.

**Course Outcomes:**

On successful completion of the course, the student will:

1. Understand the concepts of Internet of Things
2. Analyze basic protocols network
3. Design IoT applications in different domain and be able to analyze their performance

**REFERENCES:**


1. **Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”**
2. **Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"**

**CODE: PHDCE-18-02**

**SUBJECT NAME: MACHINE LEARNING**

**NO OF CREDITS: 3**

| | |
|---|---|
| **M.TECH SEMESTER I** | **SESSIONAL: 25** |
| **L T P** | **THEORY EXAM: 75** |
| **3 0 0** | **TOTAL : 100** |

**Pre-requisites:**

**Course Objectives:**

1. To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
2. To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
3. Explore supervised and unsupervised learning paradigms of machine learning.
4. To explore Deep learning technique and various feature extraction strategies.

**MODULE-1: SUPERVISED LEARNING (REGRESSION/CLASSIFICATION)**

- Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes
- Linear models: Linear Regression, Logistic Regression, Generalized LinearModels
- Support Vector Machines, Nonlinearity and Kernel Methods
- Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

**MODULE-2: UNSUPERVISED LEARNING**

- Clustering: K-means/Kernel K-means
- Dimensionality Reduction: PCA and kernel PCA
- Matrix Factorization and Matrix Completion
- Generative Models (mixture models and latent factor models)

**MODULE-3:**

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

**MODULE-4:**

Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

**MODULE-5:**

Scalable Machine Learning (Online and Distributed Learning)

A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

**MODULE-6:**

Recent trends in various learning techniques of machine learning and classification methods for IOT applications, Various models for IOT applications.

**Course Outcomes:**

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

**REFERENCES**


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

**CODE: PHDCE-18-03**

**SUBJECT NAME: WEB SEARCH AND INFORMATION RETRIEVAL**

**NO OF CREDITS: 3**

| | | |
|---|---|---|
| | **SESSIONAL:** | **25** |
| **L T P** | **THEORY EXAM:** | **75** |
| **3 0 0** | **TOTAL :** | **100** |

**Pre-requisites:** Probability Theory, Database Management, Web Programming

**Course Objectives:**

1. To build an understanding of the fundamental concepts of Information Retrieval
2. To familiarize students with the basic taxonomy and terminology of Indices
3. To understand Heap‟s Law forestimation and Zipf‟s law for modeling distribution of terms
4. To understand dictionary compression and posting list compression
5. To introduce the scoring ,tf-idf weighting and vector space model for scoring
6. To understand cluster pruning and tiered indices
7. To learn the elements of Web Search basics
8. To learn various language models for information retrieval and their types

**MODULE-1: INTRODUCTION TO INFORMATION RETRIEVAL**

Information retrieval problem, an inverted index, Processing Boolean queries ,The extended Boolean model versus ranked retrieval , an inverted index ,Bi-word indexes, Positional indexes, Combination schemes

**MODULE-2: INDEX CONSTRUCTION**

Hardware basics, Blocked sort-based indexing , Single-passin-memory indexing ,Distributed indexing, Dynamic indexing, Other types of indexes Index compression: Statistical properties of terms in information retrieval ,Heap‟s law: Estimating the number of terms, Zipf's law:Modeling the distribution of terms, Dictionary compression, Dictionarys a string, Blocked storage, Postings file compression.

**MODULE-3: SCORING, TERM WEIGHTING AND THE VECTOR SPACE MODEL**

Parametric and zone indexes ,Weighted zone scoring, Learning weights ,The optimal weight, Term frequency and weighting, Inverse document frequency, Tf-idf weighting, The vector space model for scoring, Variant tf-idf functions.

**MODULE-4: COMPUTING SCORES IN A COMPLETE SEARCH SYSTEM**

Efficient scoring and ranking, In exact top K document retrieval, Index elimination ,Champion lists, Static quality scores and ordering ,Impact ordering ,Cluster pruning ,Component so fan information retrieval system, Tiered indexes

**MODULE-5: WEB SEARCH BASICS**

Background and history, Web characteristics, The web graph, Spam, Advertising as the economic model, The search user experience, User query needs Crawling, Crawler architecture, DNS resolution, The URL frontier, Link analysis, The Web as a graph, Anchor text and the web graph ,Page Rank, Markov chains, The Page Rank computation, Topic-specific Page Rank

**MODULE-6: LANGUAGE MODELS FOR INFORMATION RETRIEVAL**

Language models, Finite automata and language models, Types of language models, Multinomial distributions over words , The query likelihood model, Using query like lihood language models in IR, Estimating the query generation probability ,Language modeling versus other approaches in IR

**Course Outcomes:**

a. The students will be able to understand basic Information Retrieval Systems.
b. The students will be able to lean how Boolean queries are processed.
c. The students will be able to identify the different types of indices: inverted index, positional index, bi-word index etc
d. The student will be able to make estimations and model distribution of terms and compressions
e. The students will be able to enumerate various types of indices. And also understand the concept of efficient storage of indices.
f. The students will be able to learn tf-idf scoring and vector space model scoring for ranking
g. The students will be able to understand Static quality ordering , cluster pruning and tiered indices h. The students will be able to understand the basic concept of Search Engines their architecture and various functional components.
i. The students will be able to understand the basic concept of Web crawlers and their architecture
j. The students will be able to understand various language models related to information retrieval

**REFERENCES**

**1. C. D. Manning, P. Raghavan and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008 (available at http://nlp.stanford.edu/IR-book).**

**2. Chakrabarti, S. (2002). Mining the web: Mining the Web: Discovering knowledge from hypertext data. Morgan-kaufman.**
**3. B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, AddisonWesley, 2009 (available at http://ciir.cs.umass.edu/irbook/).**
**4. R. Baeza-Yates, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 2011 (2nd Edition).**
**5. An Introduction to Information Retrieval Christopher D. Manning,Prabhakar Raghavan, HinrichSchütze Cambridge UniversityPress**

## Code: PHDCE-17-01

## Subject Name: WIRELESS SENSOR NETWORKS

## Course Objectives:

1. To make the student understand the basic Adhoc Networks and its design issues.
2. To understand the fundamentals of WSN and its distinguishing features from MANET.
3. To understand the middleware and operating system design issues of WSN
4. To understand the physical layer protocols and their design issues
5. To discuss the challenges in designing various MAC and routing protocols for WSN
6. To understand the taxonomy of routing protocols of WSN
7. To discuss the transport layer and application layer protocols of WSN
8. To discuss the security mechanism and attacks in WSN

**Unit I : OVERVIEW OF ADHOC AND WIRELESS SENSOR NETWORKS**

Wireless Networks, Infrastructure and Infrastructure less Wireless Networks, Ad hoc Wireless Networks, Types of Ad hoc Mobile Communications, Challenges Facing Ad hoc Mobile Networks, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks.

Basic definition and concepts of Wireless Networks, design principles for WSNs, comparison of MANET & WSN, Architecture and Protocol Stack of WSN, Unique constraints and challenges of WSNs, Applications of WSNs(Military Applications, Environmental Applications, Health Applications, Home Applications).

**Unit II : MIDDLEWARE & OPERATING SYSTEMS FOR WSN WSN**

Middleware Principles, Middleware Architecture, Existing Middleware (Milan, IrisNET,CLMF,MLM),Operating systems Design Issues, Examples of Operating Systems

**Unit III : PHYSICAL & DATA LINK LAYER OF WSN**

Physical Layer Technologies & Standards, Channel Coding,Source Coding, PHY Layer Standards, Challenges for MAC, Classification of MAC Protocols , Contention free and Contection Based MAC Protocols.

**Unit IV : NETWORK LAYER**

Challenges for Routing,Classification of Protocols, Data–Centric and Flat Architecture Protocols (Flooding,Gossiping,SPIN) Heirarchical protocols (

LEACH,PEGASIS,TEEN,APTEEN ), Location Based(Unicast, Multicast, GeoCast) and QoS based(Sequential Assignment,SPEED) Routing Protocols.

**Unit V : TRANSPORT & APPLICATION LAYER**

Challenges for Transport Layer, RMST Protocol, PSFQ Protocol, CODA Protocol, ESRT Protocol Source Coding, Query Processing, Network Management.

**Unit VI : SECURITY IN WSN**

Challenges of Security in WSN, Security Attacks in WSN, Protocols and Mechanisms for Security, IEEE 802.15.4 and ZigBee Security Course Outcomes At the end of the course/session the student would be

**Course Outcomes**

**At the end of the course/session the student would be**

a. Acquainted with the basic concept of MANET

b. Become familiar with the application domain and design principles of WSN

c. Have a detailed knowledge of the design principles for operating system of WSN

e. Learned the physical and data link layer protocols of WSN

f. Acquainted with the various categories of routing protocols of WSN

g. Become familiar with the transport and application layer protocols available in WSN

h. Become familiar with the various types of attacks in WSN and their security mechanisms