5. Write a program to implement a B-Tree.
6. Write a program to implement the Tree Data structure, which supports the following operations:
   I. Insert
   II. Search
7. Write a program to search a pattern in a given text using the KMP algorithm.
8. Write a program to implement a Suffix tree.

## DISCIPLINE SPECIFIC CORE COURSE – 16 (DSC-16): Theory of Computation

**Credit distribution, Eligibility and Prerequisites of the Course**

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **DSC 16 Theory of Computation** | **4** | **3** | **0** | **1** | Pass in Class XII | DSC04 Object Oriented Programming with C++ / GE1a Programming using C++ /A course in C/C++ at plus 2 level |

### Learning Objectives

This course introduces formal models of computation, namely, finite automaton, pushdown automaton, and Turing machine; and their relationships with formal languages. make students aware of the notion of computation using abstract computing devices. Students will also learn about the limitations of computing machines as this course addresses the issue of which problems can be solved by computational means (decidability vs undecidability

### Learning outcomes

On successful completion of the course, students will be able to:

- design a finite automaton, pushdown automaton or a Turing machine for a problem at hand.

- apply pumping lemma to prove that a language is non-regular/non-context-free.
- describe limitations of a computing machines and
- recognize what can be solved and what cannot be solved using these machines.

## SYLLABUS OF DSC 14

**Unit 1 (7 hours)**

**Introduction:** Alphabets, string, language, basic operations on language, concatenation, union, Kleene star.

**Unit 2 (15 hours)**

**Finite Automata and Regular:** Regular expressions, Deterministic Finite Automata (DFA), Non-deterministic Finite Automata (NFA), relationship between NFA and DFA, Transition Graphs (TG), properties of regular languages, the relationship between regular languages and finite automata, pumping lemma, Kleene's theorem.

**Unit 3 (15 hours)**

**Context-Free Languages (CFL):** Context-Free Grammars (CFG), deterministic and non-deterministic Pushdown Automata (PDA), relationship between CFG and PDA, parse trees, leftmost derivation, Ambiguities in grammars, pumping lemma for CFL, properties of CFL, Chomsky Normal Form.

**Unit 4 (8 hours)**

**Turing Machines and Models of Computations:** Turing machine as a model of computation, configuration of Turing machine, Recursive and recursively enumerable languages, Church Turing Thesis, Universal Turing Machine, decidability, Halting problem.

**Essential/recommended readings**


1. Harry R. Lewis and Christos H. Papadimitriou, *Elements of the Theory of Computation*, 2nd Edition, Prentice Hall of India (PHI), 2002
2. Daniel I.A. Cohen, *Introduction to Computer Theory*, 2nd Edition, Wiley India Pvt. Ltd., 2011.


**Additional References**


1. J.E. Hopcroft, R. Motwani, and J.D. Ullman, *Introduction to Automata Theory, Languages and Computation*, 3rd edition, Addison Wesley, 2006.
2. Peter Linz, *An Introduction to Formal Languages and Automata*, 6th edition, Jones & Bartlett Learning, 2017.
3. Michael Sipser, *Introduction to the Theory of Computation*, Cengage, 2014

DSC17 / **DSC-A6/DSE: DEEP LEARNING**

Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **Deep Learning** | **4** | **3** | **0** | **1** | Pass in Class XII | Programming using Python/Object Oriented Programming using Python/Mathematics for Computing |

**Course Objectives**

The objective of this course is to introduce students to deep learning algorithms and their applications in order to solve real problems.

**Learning outcomes**

On successful completion of this course, the student will be able to:

• Describe the feed-forward and deep networks.

• Design single and multi-layer feed-forward deep networks and tune various hyper parameters.

• Implement deep neural networks to solve a problem

• Analyze performance of deep networks.

• Use pre-trained models to solve a problem.

**SYLLABUS**

**Unit 1** **(8 Hours)**

**Introduction to neural networks:**

Artificial neurons, perceptron, computational models of neurons, Structure of neural networks, Multilayer feedforward neural networks (MLFFNN), Backpropagation learning, Empirical risk minimization, bias-variance tradeoff, Regularization, output units: linear, softmax , hidden units:tanh, RELU

**Unit 2** **(8 Hours)**

**Deep neural networks:**

Difficulty of training DNNs, Greedy layerwise training, Optimization for training DNN's, Newer optimization methods for neural networks(AdaGrad, RMSProp, Adam), Regularization methods(dropout, drop connect, batch normalization).

**Unit 3** **(8 Hours)**

**Convolution neural networks(CNNs):**

Introduction to CNN - convolution, pooling, Deep CNNs - LeNet, AlexNet. Training CNNs, weights initialization, batch normalization, hyperparameter optimization, Using a pre trained convnet

**Unit 4** **(8 Hours)**

**Recurrent neural networks (RNNs):**

Sequence modeling using RNNs, Backpropagation through time, LongShort Term Memory (LSTM), Bidirectional RNN

**Unit 5** **(8 Hours)**

**Unsupervised deep learning:**

Autoencoders, Generative Adversarial Networks.

**Unit 6** **(5 Hours)**

**Applications:**

Computer vision, Speech recognition and NLP.

**Essential/recommended readings**

1. Ian Goodfellow, Yodhua Bengio and Aaron Courville, Deep Learning, MIT Press Book, 2016.

2. Francois Chollet, Deep Learning with python, 2nd edition, Meaning Publications Co, 2021.

**Additional References**

1. Bunduma, N., Fundamentals of Deep Learning, 1st edition, O'reilly Books, 2017.

2. Heaton, J., Deep Learning and Neural Networks, 1st edition, Heaton Research Inc., 2015.

**Suggested Practical List :**

**Practical exercises such as**

The following practicals are to be conducted using Python.

1. Implement a feed-forward neural networks for classifying movie reviews as positive or negative(using IMDB dataset)
2. Implement a deep-neural feed-forward network for estimating the price of house, given real-estate data(Boston Housing Price)
3. Implement a deep-neural network for classifying news wires by topic (Reuters dataset).
4. Implement CNN for classifying MNIST dataset
5. Create a model for time-series forecasting using RNN/LSTM 6. Implement an auto-encoder

# DSE: NUMERICAL OPTIMIZATION

### Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | Eligibility criteria | |
|---|---|---|---|---|

## DISCIPLINE SPECIFIC ELECTIVE COURSE: Computer Graphics

**Credit distribution, Eligibility and Pre-requisites of the Course**

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **Computer Graphics** | **4** | **3** | **1** | **0** | Pass in Class XII | DSC 03 (Mathematics for Computing - I), DSC 04 Object Oriented Programming with C++/ GE 1a Programming using C++ / GE1b Programming with Python/ DSC 01 Programming using Python/ GE 3b Java Programming |

**Learning Objectives**

This course introduces fundamental concepts of Computer Graphics with focus on modeling, rendering and interaction aspects of computer graphics. The course emphasizes the basic principles needed to design, use and understand computer graphics system.

**Learning outcomes**

On successful completion of the course, students will be able to:

- Describe Standard raster and vector scan devices as well as Graphical Input and output devices
- Implement algorithms for drawing basic primitives such as line, circle and ellipse.
- Implement algorithms for line clipping, polygon clipping and polygon filling.
- Implement a 3D object representation scheme, carryout 2D and 3D transformation, 3D projections
- Implement visible surface determination algorithms, Illumination models and surface rendering methods
- Implement a simple computer animation algorithm

**SYLLABUS OF DSE**

**Unit 1 (8 Hours)**

**Introduction:** Introduction to Graphics systems, Basic elements of Computer graphics, Applications of computer graphics. Architecture of Raster and Random scan display devices, input/output devices.

**Unit 2 (8 Hours)**
**Drawing and clipping primitives:** Raster scan line, circle and ellipse drawing algorithms, Polygon filling, line clipping and polygon clipping algorithms

**Unit 3 (12 Hours)**
**Transformation and Viewing:** 2D and 3D Geometric Transformations, 2D and 3D Viewing transformations (Projections- Parallel and Perspective), Vanishing points.

**Unit 4 (9 Hours)**
**Geometric Modeling:** Polygon Mesh Representation, Cubic Polynomial curves (Hermite and Bezier).

**Unit 5 (8 Hours)**
**Visible Surface determination and Surface Rendering:** Z-buffer algorithm, List-priority algorithm and area subdivision algorithm for visible surface determination. Illumination and shading models, RGB Color model and Basics of Computer Animation.

**Essential/recommended readings**


1. Hearn, D & Baker, M.P. *Computer Graphics*, 2nd edition, Prentice Hall of India, 2009.
2. Foley, J. D., Dam, A.V, Feiner, S. K., & Hughes, J. F. *Computer Graphics: Principles and Practice in C*, 2nd edition, Pearson education, 2002.
3. Rogers, D. F. *Mathematical Elements for Computer Graphics*, 2nd edition, McGraw Hill Education, 2017.


**Additional References**


1. Bhattacharya, S. *Computer Graphics*, Oxford University Press, 2018.
2. Marschner, S., & Shirley, P. *Fundamentals of Computer Graphics,* 4th edition CRC Press, 2017.


**Suggested Practical List :**

**Practical exercises such as**

1. Write a program to implement Bresenham's line drawing algorithm.
2. Write a program to implement a midpoint circle drawing algorithm.
3. Write a program to clip a line using Cohen and Sutherland line clipping algorithm.
4. Write a program to clip a polygon using Sutherland Hodgeman algorithm.
5. Write a program to fill a polygon using the Scan line fill algorithm.
6. Write a program to apply various 2D transformations on a 2D object (use homogeneous Coordinates).
7. Write a program to apply various 3D transformations on a 3D object and then apply parallel and perspective projection on it.
8. Write a program to draw Hermite /Bezier curve.

# DSC-A6/DSE: DEEP LEARNING

Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **Deep Learning** | **4** | **3** | **0** | **1** | Pass in Class XII | Programming using Python/Object Oriented Programming using Python/Mathematics for Computing |

**Course Objectives**

The objective of this course is to introduce students to deep learning algorithms and their applications in order to solve real problems.

**Learning outcomes**

On successful completion of this course, the student will be able to:

• Describe the feed-forward and deep networks.

• Design single and multi-layer feed-forward deep networks and tune various hyper parameters.

• Implement deep neural networks to solve a problem

• Analyze performance of deep networks.

• Use pre-trained models to solve a problem.

**SYLLABUS**

**Unit 1** **(8 Hours)**

**Introduction to neural networks:**

Artificial neurons, perceptron, computational models of neurons, Structure of neural networks, Multilayer feedforward neural networks (MLFFNN), Backpropagation learning, Empirical risk minimization, bias-variance tradeoff, Regularization, output units: linear, softmax , hidden units:tanh, RELU

**Unit 2** **(8 Hours)**

**Deep neural networks:**

Difficulty of training DNNs, Greedy layerwise training, Optimization for training DNN's, Newer optimization methods for neural networks(AdaGrad, RMSProp, Adam), Regularization methods(dropout, drop connect, batch normalization).

**Unit 3** **(8 Hours)**

**Convolution neural networks(CNNs):**

Introduction to CNN - convolution, pooling, Deep CNNs - LeNet, AlexNet. Training CNNs, weights initialization, batch normalization, hyperparameter optimization, Using a pre trained convnet

**Unit 4** **(8 Hours)**

**Recurrent neural networks (RNNs):**

Sequence modeling using RNNs, Backpropagation through time, LongShort Term Memory (LSTM), Bidirectional RNN

**Unit 5** **(8 Hours)**

**Unsupervised deep learning:**

Autoencoders, Generative Adversarial Networks.

**Unit 6** **(5 Hours)**

**Applications:**

Computer vision, Speech recognition and NLP.

**Essential/recommended readings**

1. Ian Goodfellow, Yodhua Bengio and Aaron Courville, Deep Learning, MIT Press Book, 2016.

2. Francois Chollet, Deep Learning with python, 2nd edition, Meaning Publications Co, 2021.

**Additional References**

1. Bunduma, N., Fundamentals of Deep Learning, 1st edition, O'reilly Books, 2017.

2. Heaton, J., Deep Learning and Neural Networks, 1st edition, Heaton Research Inc., 2015.

**Suggested Practical List :**

**Practical exercises such as**

The following practicals are to be conducted using Python.

1. Implement a feed-forward neural networks for classifying movie reviews as positive or negative(using IMDB dataset)
2. Implement a deep-neural feed-forward network for estimating the price of house, given real-estate data(Boston Housing Price)
3. Implement a deep-neural network for classifying news wires by topic (Reuters dataset).
4. Implement CNN for classifying MNIST dataset
5. Create a model for time-series forecasting using RNN/LSTM 6. Implement an auto-encoder

# DSE: NUMERICAL OPTIMIZATION

**Credit distribution, Eligibility and Pre-requisites of the Course**

| Course title & Code | Credits | Credit distribution of the course | Eligibility criteria | |
|---|---|---|---|---|

1. Peter Kim, The Hacker Playbook 3: Practical Guide to Penetration Testing, Zaccheus Entertainment, 2018.
2. Jon Erickson, Hacking: The Art of Exploitation, No Starch Press, 2008.
3. Online Resources:

https://www.sans.org/cyberaces/

https://skillsforall.com/

https://www.hackingloops.com/ethical-hacking/

**Suggested Practical List (If any): (30 Hours)**

**Perform the following activities, record and report in standard form.**

(NOTE: Exercise extra caution while performing these exercises and codes)

1. Perform various Virtual Machine based exercises on https://vulnhub.com/
2. Perform Capture the Flag (CTF) exercises from https://www.hacker101.com/
3. Follow the lessons and activities from https://www.hackingloops.com/ethical-hacking/
4. Google site for hacking https://google-gruyere.appspot.com/
5. OWASP WebGoat https://github.com/WebGoat/WebGoat

## GE8d/DSE: CYBER FORENSICS

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Cyber Forensics** | **4** | **3** | **0** | **1** | **Pass in Class XII** | **NIL** |

**Course Objective:**

This course is to equip students with the knowledge and skills necessary to identify, collect, analyze and present digital evidence in a manner that is admissible in legal proceedings. Students will be able to conduct a thorough investigation of cybercrime incidents, preserve digital evidence, and report findings to relevant stakeholders.

**Course Learning Outcomes:**

- Students will be able to demonstrate an understanding of the principles of digital forensics, including legal considerations, recognition, collection, and preservation of digital evidence.
- Students will develop skills in using digital forensics tools and techniques, such as creating disk images, conducting keyword and grep searches, and examining Windows registry.
- Students will learn evidence recovery methods, including deleted file recovery, formatted partition recovery, and data recovery procedures, and ethical considerations.
- Students will gain knowledge of cyber forensic investigation tools and techniques, including digital evidence collection, preservation, and password cracking.
- Students will understand cyber laws and crimes, including hacking, viruses, intellectual property, and e-commerce, and the legal system of information technology, including jurisdiction issues and security and evidence in e-commerce.

**Unit 1 – Digital Forensics**: Introduction to digital forensics, legal considerations, recognising and collecting digital evidence, preservation of evidence, hash values and file hashing, creating disk images, keyword and grep searches, network basics, reporting and peer review, digital forensics report.

**Unit 2 – Windows OS Forensics:** Bits, bytes, Endieness, Disk partition schema, File systems – FAT, NTFS, ex-FAT, windows registry forensics, examining windows registry, NTUser.Dat Hive File Analysis, SAM Hive file, Software Hive file, System Hive File, USRClass.dat Hive File, AmCache Hive File.

**Unit 3 – Evidence Recovery:** Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, Complete time line analysis of computer files based on file creation, File modification and file access, Recover Internet Usage Data, Recover Swap Files/Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK), Use computer forensics software tools to cross validate findings in computer evidence.

**Unit 4 – Investigation:** Introduction to Cyber Forensic Investigation, Investigation Tools, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Encryption and Decryption methods, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking.

**Unit 5 – Cyber Crimes and Cyber Laws:** Introduction to IT laws & Cyber Crimes, Internet, Hacking, Cracking, Viruses, Software Piracy, Intellectual property, Legal System of Information Technology, Understanding Cyber Crimes in context of Internet, Indian Penal Law & Cyber Crimes Fraud Hacking Mischief, International law, E-Commerce-Salient Features On-Line contracts Mail Box rule Privities of, Contracts Jurisdiction issues in E-Commerce Electronic Data Interchange, Security and Evidence in E-Commerce Dual Key encryption Digital signatures security issues.

**References:**

1. Marjee T. Britz, Computer Forensics and Cyber Crime: An Introduction, Pearson Education, 2013.

2. C. Altheide& H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011. ISBN: 9781597495868.

**Additional References:**

1. Computer Forensics: Investigating Network Intrusions and Cybercrime" by Cameron H. Malin, Eoghan Casey, and James M. Aquilina

2. Online Course management System: https://esu.desire2learn.com/

3. Computer Forensics, Computer Crime Investigation by John R,Vacca, Firewall Media, New Delhi.

4. Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning

5. Real Digital Forensics by Keith j.Jones, Richard Bejitlich,Curtis W.Rose ,AddisonWesley Pearson Education

**Suggested Practicals**

It is suggested that the following tools/e-resources can be explored during the practical sessions • Wireshark • COFEE Tool • Magnet RAM Capture • RAM Capture • NFI Defragger • Toolsley • Volatility

1. Study of Network Related Commands (Windows)
2. Study of Network related Commands(Linux)
3. Analysis of windows registry
4. Capture and analyze network packets using Wireshark. Analyze the packets captured.
5. Creating a Forensic image using FTK Imager/ Encase Imager: creating forensic image, check integrity of data, analyze forensic image
6. Using System internal tools for network tracking and process monitoring do the following:
    a. Monitor live processes
    b. Capture RAM
    c. Capture TCP/UDP packets
    d. Monitor Hard disk
    e. Monitor Virtual Memory
    f. Monitor Cache Memory

## DSC20/DSC08/GE8a: INFORMATION SECURITY

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |

2. Q. Kong, T. Siauw, A. Bayen, *Python Programming and Numerical Methods: A Guide for Engineers and Scientists*, 1st edition, 2020.

Suggested Practical List (If any)

:(30 Hours)

Practical exercises such as

Write programs to implement the following methods:

Constrained and Unconstrained Optimization, Global and Local Optimization, Line Search and Trust Region, Convergence of Line Search Methods, Rate of Convergence - Convergence Rate of Steepest Descent, Newton's Method, Quasi-Newton Methods, The Cauchy Point algorithm, Finite-Difference Derivative Approximations, Convergence to Stationary Points, Conjugate Gradient Method, Rate of Convergence, Approximating a Sparse Jacobian, Approximating the Hessian, Approximating a Sparse Hessian, First-Order Optimality Condition, Second-Order Conditions - Second-Order Conditions, and Projected Hessians. Linear and non-linear constrained optimization Augmented Lagrangian Methods.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

## GE7e/DSE: ETHICAL HACKING

Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Ethical Hacking** | **4** | **3** | **0** | **1** | **Pass in Class XII** | **NIL** |

**Course Objectives**

The objective of this course is to enable students to be part of such a team that can conduct the security assessment of an organization through the process of ethical hacking. This course will introduce the students, the idea of security assessment of systems and networks under investigation and how to perform them under the legal and ethical framework. Further, this course will outline the importance of various stages of ethical hacking, including but not limited to tasks such as penetration testing, and usage of various tools at each stage.

**Learning outcomes**

On successful completion of the course, students will be able to:

1. Understand and acknowledge the relevance of legal, ethical, and professional challenges faced by an ethical hacker.
2. Apply fundamental principles of system, application, and network security to ethically attack / penetrate the system to uncover the security flaws.
3. Perform evaluation of security systems through a systematic ethical hacking process and recommend countermeasures to improve security.
4. Understand and use various tools and techniques used in various stages of the ethical hacking process.

**Syllabus**

**Unit 1** **(4 Hours)**

**Introduction:** Overview of information security threats and attack vectors, vulnerability assessment and penetration testing concepts, information security controls, security laws and standards. OWASP top 10 vulnerabilities

**Unit 2** **(6 hours)**

**Footprinting and Reconnaissance:** Introduction to network reconnaissance tools such ipconfig, ifconfig, domain tools, nmap, Wireshark, etc.

**Unit 3** **(8 hours)**

**Scanning and Enumeration:** Network penetration testing, Password cracking techniques and countermeasures, NetBIOS tools

**Unit 4** **(8 hours)**

**Gaining and Maintaining Access:** Network level attacks and countermeasures, Metasploit framework, Burp Suite

**Unit 5** **(8 hours)**

**Exploitation and Covering Tracks:** Privilege escalation, social Engineering**,** identity theft, countermeasures, Covering tracks using attrib command and creating Alternate Data Stream (ADS) in Windows, Erasing evidence from Windows logs, Strategies for maintaining access.

**Unit 6** **(8 hours)**

**Advanced stages:** Denial of service, Session hijacking, hacking web servers, hacking web applications, sql injection etc.

**Unit 7** **(8 hours)**

**NIST Cybersecurity framework and ISO standards:** NIST cybersecurity framework, Cyber Kill chain, ISO/IEC 27001 and related standards.

**Unit 8** **(4 Hours)**

**Cyber Defense and Reporting:** Preparing vulnerability assessment reports, presenting post testing findings, preparing recommendations

References

1. Patrick Engbretson, The Basics of Hacking and Penetration Testing, 2nd Edition, Syngress, 2013.
2. Georgia Weidman, Penetration TEsting: A Hands-On Introduction to Hacking, 1st Edition, No Starch Press, 2014.

**Additional References**

1. Peter Kim, The Hacker Playbook 3: Practical Guide to Penetration Testing, Zaccheus Entertainment, 2018.
2. Jon Erickson, Hacking: The Art of Exploitation, No Starch Press, 2008.
3. Online Resources:

https://www.sans.org/cyberaces/

https://skillsforall.com/

https://www.hackingloops.com/ethical-hacking/

**Suggested Practical List (If any): (30 Hours)**

**Perform the following activities, record and report in standard form.**

(NOTE: Exercise extra caution while performing these exercises and codes)

1. Perform various Virtual Machine based exercises on https://vulnhub.com/
2. Perform Capture the Flag (CTF) exercises from https://www.hacker101.com/
3. Follow the lessons and activities from https://www.hackingloops.com/ethical-hacking/
4. Google site for hacking https://google-gruyere.appspot.com/
5. OWASP WebGoat https://github.com/WebGoat/WebGoat

## GE8d/DSE: CYBER FORENSICS

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| | | | | | | |

## DISCIPLINE SPECIFIC ELECTIVE COURSES

## DISCIPLINE SPECIFIC ELECTIVE COURSE: Social Network Analytics

**Credit distribution, Eligibility and Pre-requisites of the Course**

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **Social Network Analytics** | **4** | **3** | **0** | **1** | Pass in Class XII | DSC 01 Programming using Python, DSC03 Mathematics for Computing |

**Learning Objectives**

The course introduces basic graph theory and draws distinction between graph as an abstract structure and real-life situation modelled as network. This course aims to expose the students to the strengths and capabilities of network analysis and their applications through the use of open source software.

**Learning outcomes**

On successful completion of the course, students will be able to :

- Model real life situation as networks
- Identify and apply quantitative network measures to characterize social networks at the local and global level
- Generate synthetic networks that satisfy properties of real world networks
- Discover, analyse and evaluate the intrinsic community structure of networks
- Model an information diffusion process for predictive analysis of networks

**SYLLABUS OF DSE**

**Unit 1 (7 Hours)**

**Introduction to Social Network Analysis:** Graph theory, random walk, degree distribution, mapping of real world situation into networks and applications of social network analysis, types of networks

**Unit 2 (10 Hours)**

**Network Measures:** Centrality measures, Page Rank, Hubs and Authority, Assortativity, Transitivity and Reciprocity, Similarity and Structural Equivalence

**Unit 3 (10 Hours)**

**Network Models:** Properties of Real-World Networks, Random Network Model, Small World Network Model, Preferential Attachment Model

**Unit 4 (10 Hours)**

**Community Structure in Networks:** Types of Communities, Community Detection algorithms and evaluation of communities obtained

**Unit 5 (8 Hours)**

**Information Diffusion in Social Media:** Information Cascades, Diffusion of Innovations, Basic Epidemic Models

**Essential/recommended readings**


1. Chakraborty T. *Social Network Analysis*, 1st edition, Wiley India Pvt. Ltd., 2021.
2. Zafarani R., Abbasi M. A., Liu H. *Social Media Mining: An Introduction*, 1st edition, Cambridge University Press, 2014.
3. Barabási A. L. , Pósfai M. *Network Science*, 1st edition, Cambridge University Press, 2016.


**Additional References**


1. Easley, Kleinberg J. *Networks, Crowds, and Markets: Reasoning About a Highly Connected World*, 1st edition, Cambridge University Press, 2012.


**Suggested Practical List :**

**Practical exercises such as**

**Python Packages like igraph, NetworkX, NDlib etc. may be used for programming**

1. Plot a weighted directed network such that node size and edge width is proportional to their degree and edge weight respectively
2. Compute and plot degree distribution of a real-world network. Also compute its local and global properties.
3. Generate three networks of 1000 nodes each using Random Network Model, Small World Network Model, Preferential Attachment Model and compare their characteristics.
4. Compute different centrality measures to identify top-N nodes and compare their ranks with those obtained by PageRank method.
5. Apply community detection algorithms on a small real-world network (e.g. Karate club) and compare modularity using bar plot. Also plot the communities revealed with different colors.
6. Simulate diffusion trends for different epidemic models and present results using appropriate visuals.

**Annexure-1**

# Syllabus of Discipline Specific Elective VI/VII Semester
# (NEP UGCF 2022)

**(Effective from Academic Year 2024-25)**

**DISCIPLINE SPECIFIC ELECTIVE (DSE): Research Methodology**

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **Research Methodology** | **4** | **3** | **0** | **1** | **Pass in Class XII** | **NIL** |

**Course Objective**

This course allows the students to acquire the necessary skills to conduct research in computer science. It enables the students to understand the entire process of research from problem identification, literature review, designing the project to documenting the outcome.

**Course Learning Outcomes**

On the successful completion of the course, the student would be able to:

- Identify the problem after conduct of a literature survey.
- Define goals, approach, and scope of the research.
- Explore, download and interpret datasets.
- Effectively record study findings in a research paper format.

**Syllabus of DSE**

**Unit 1 : 8 Hours**

**Research Fundamentals**: Meaning and significance of research, requirements and characteristics of research, types of research - basic, applied analytical, conceptual, empirical, experimental, non-experimental, prospective, retrospective, exploratory / descriptive, qualitative, quantitative, mixed method. Research process, induction and deduction in research, introduction to research tools, qualities of a good researcher.

**Unit 2 : 5 Hours**

**Problem Identification:** Choosing an appropriate problem area, identifying sources of research articles, literature review – stating and evaluating the research problem, techniques and methodologies, state of the art.

**Unit 3 : 12 Hours**

**Data Analytics:** Exploring and organizing data sets, pre-processing data, interpreting the data. Choosing appropriate statistics. Descriptive statistics - measures of central tendency and variability, measures of association. Inferential statistics – estimating population parameters, testing hypothesis.

**Unit 4 : 10 Hours**

**Presenting research outcomes:** Essential elements of a research paper - explanation of the research problem, description of methods and data, data analysis and its interpretation, identification of possible weaknesses of the study, presenting and summarizing the research output, drawing conclusions.

**Unit 5 : 5 Hours**

**Publication:** Process of journal submission and review. Peer review process - single, blind and double blind. Professional research societies, scientometric analysis - citation index and analysis, plagiarism, plagiarism checker.

**Unit 6 : 5 Hours**

**Research Ethics:** Ethical issues in research, protection from harm, voluntary and informed participation, right to privacy, conflict of interest, honesty with professional colleagues, professional code of ethics, intellectual property rights, fraud and misconduct in science.

**Essential/recommended readings**


1. Thomas, C. G. (2021). Research Methodology and Scientific Writing, 2nd Ed. Springer.
2. Leedy, P. D., & Ormrod, J. E. (2016). Practical Research: Planning and Design, 11th Ed. Pearson.


**Additional References:**


1. Ghezzi. C. *Being a Researcher: An Informatics Perspective.* Springer
2. Locharoenrat, K. (2018). *Research Methodologies for Beginners.* PAN Stanford Publication.
3. https://www.unesco.org/en/articles/what-you-need-know-about-unescos-new-ai-competency-frameworks-students-and-teachers?hub=32618


**Suggested Practical List**

**Capstone Project:** Students must choose an area of interest for research, based on the curriculum (but not limited by it) covered in the program. They should identify a research problem to solve. During the semester the students must document the research journey in the form of a report, which will be evaluated at the end of the semester. The students are encouraged to write a research paper based on the report, under the guidance of the teacher. The practical class for research methodology course should be utilized to perform the following tasks in the research process.

1. Search the research papers related to the chosen problem using academic search engines like Google Scholar, Scopus search, Web of Science database, etc.

a. Evaluate the venue of the source of research paper - Journals using citation metrics like CiteScore, SCImago Journal Rank (SJR)), Source Normalized Impact per Paper (SNIP) etc., Conferences venues are evaluated using indexing information, Core Ranking etc.
b. Summarize the reviewed papers in a tabular format with columns: Paper Title, Author(s), Year, Key Findings, and Citation Count.
c. Explore reference management tools like Mendley / Zotero / EndNote to organize, store, and manage references.

2. Practice data analysis techniques taught in the class and identify a suitable technique required to solve the chosen research problem.

3. Write the research report and prepare to write the research paper.

a) Choose a document writing software and prepare the report as per the format given by the teacher.
b) Use the plagiarism check tool to assess the similarity index of the report and ensure that it is less than 10%.
c) Explore the journal finder tools available for the publishers and select a suitable journal to submit the manuscript

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1. Peter Kim, The Hacker Playbook 3: Practical Guide to Penetration Testing, Zaccheus Entertainment, 2018.
2. Jon Erickson, Hacking: The Art of Exploitation, No Starch Press, 2008.
3. Online Resources:

https://www.sans.org/cyberaces/

https://skillsforall.com/

https://www.hackingloops.com/ethical-hacking/

**Suggested Practical List (If any): (30 Hours)**

**Perform the following activities, record and report in standard form.**

(NOTE: Exercise extra caution while performing these exercises and codes)

1. Perform various Virtual Machine based exercises on https://vulnhub.com/
2. Perform Capture the Flag (CTF) exercises from https://www.hacker101.com/
3. Follow the lessons and activities from https://www.hackingloops.com/ethical-hacking/
4. Google site for hacking https://google-gruyere.appspot.com/
5. OWASP WebGoat https://github.com/WebGoat/WebGoat

## GE8d/DSE: CYBER FORENSICS

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Cyber Forensics** | **4** | **3** | **0** | **1** | **Pass in Class XII** | **NIL** |

**Course Objective:**

This course is to equip students with the knowledge and skills necessary to identify, collect, analyze and present digital evidence in a manner that is admissible in legal proceedings. Students will be able to conduct a thorough investigation of cybercrime incidents, preserve digital evidence, and report findings to relevant stakeholders.

**Course Learning Outcomes:**

- Students will be able to demonstrate an understanding of the principles of digital forensics, including legal considerations, recognition, collection, and preservation of digital evidence.
- Students will develop skills in using digital forensics tools and techniques, such as creating disk images, conducting keyword and grep searches, and examining Windows registry.
- Students will learn evidence recovery methods, including deleted file recovery, formatted partition recovery, and data recovery procedures, and ethical considerations.
- Students will gain knowledge of cyber forensic investigation tools and techniques, including digital evidence collection, preservation, and password cracking.
- Students will understand cyber laws and crimes, including hacking, viruses, intellectual property, and e-commerce, and the legal system of information technology, including jurisdiction issues and security and evidence in e-commerce.

**Unit 1 – Digital Forensics**: Introduction to digital forensics, legal considerations, recognising and collecting digital evidence, preservation of evidence, hash values and file hashing, creating disk images, keyword and grep searches, network basics, reporting and peer review, digital forensics report.

**Unit 2 – Windows OS Forensics:** Bits, bytes, Endieness, Disk partition schema, File systems – FAT, NTFS, ex-FAT, windows registry forensics, examining windows registry, NTUser.Dat Hive File Analysis, SAM Hive file, Software Hive file, System Hive File, USRClass.dat Hive File, AmCache Hive File.

**Unit 3 – Evidence Recovery:** Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, Complete time line analysis of computer files based on file creation, File modification and file access, Recover Internet Usage Data, Recover Swap Files/Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK), Use computer forensics software tools to cross validate findings in computer evidence.

**Unit 4 – Investigation:** Introduction to Cyber Forensic Investigation, Investigation Tools, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Encryption and Decryption methods, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking.

**Unit 5 – Cyber Crimes and Cyber Laws:** Introduction to IT laws & Cyber Crimes, Internet, Hacking, Cracking, Viruses, Software Piracy, Intellectual property, Legal System of Information Technology, Understanding Cyber Crimes in context of Internet, Indian Penal Law & Cyber Crimes Fraud Hacking Mischief, International law, E-Commerce-Salient Features On-Line contracts Mail Box rule Privities of, Contracts Jurisdiction issues in E-Commerce Electronic Data Interchange, Security and Evidence in E-Commerce Dual Key encryption Digital signatures security issues.

**References:**

1. Marjee T. Britz, Computer Forensics and Cyber Crime: An Introduction, Pearson Education, 2013.

2. C. Altheide& H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011. ISBN: 9781597495868.

**Additional References:**

1. Computer Forensics: Investigating Network Intrusions and Cybercrime" by Cameron H. Malin, Eoghan Casey, and James M. Aquilina

2. Online Course management System: https://esu.desire2learn.com/

3. Computer Forensics, Computer Crime Investigation by John R,Vacca, Firewall Media, New Delhi.

4. Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning

5. Real Digital Forensics by Keith j.Jones, Richard Bejitlich,Curtis W.Rose ,AddisonWesley Pearson Education

**Suggested Practicals**

It is suggested that the following tools/e-resources can be explored during the practical sessions • Wireshark • COFEE Tool • Magnet RAM Capture • RAM Capture • NFI Defragger • Toolsley • Volatility

1. Study of Network Related Commands (Windows)
2. Study of Network related Commands(Linux)
3. Analysis of windows registry
4. Capture and analyze network packets using Wireshark. Analyze the packets captured.
5. Creating a Forensic image using FTK Imager/ Encase Imager: creating forensic image, check integrity of data, analyze forensic image
6. Using System internal tools for network tracking and process monitoring do the following:
    a. Monitor live processes
    b. Capture RAM
    c. Capture TCP/UDP packets
    d. Monitor Hard disk
    e. Monitor Virtual Memory
    f. Monitor Cache Memory

## DSC20/DSC08/GE8a: INFORMATION SECURITY

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |

# DSC12/DSC06/GE6a: COMPUTER NETWORKS

Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **Computer Networks** | **4** | **3** | **0** | **1** | Pass in Class XII | NIL |

**Course Objectives**

The course objectives of this paper are to:

• Understand the concepts behind computer networks and data communication.

• Learn the different types of networks, network topologies and their characteristics.

• Learn the working of protocols used at various layers.

• Understand the utility of different networking devices.

**Learning Outcomes**

Upon successful completion of the course, students will be able to:

• differentiate between various types of computer networks and their topologies.

• understand the difference between the OSI and TCP/IP protocol suit.

• distinguish between different types of network devices and their functions.

• design/implement data link and network layer protocols in a simulated networking environment.

**Syllabus**

**Unit 1** **(8 hours)**

**Introduction:**

Types of computer networks, Internet, Intranet, network topologies (bus, star, ring, mesh, tree, hybrid topologies), network classifications. layered architecture approach, OSI Reference Model, TCP/IP Reference Model. Transmission Modes: simplex, half duplex and full duplex, network devices and their role.

**Unit 2** **(9 hours)**

**Physical Layer:**

Analog signal, digital signal, the maximum data rate of a channel, transmission media (guided transmission media, wireless transmission, satellite communication), multiplexing (frequency division multiplexing, time-division multiplexing, wavelength division multiplexing). Guided Media (Wired) (Twisted pair, Coaxial Cable, Fiber Optics. Unguided Media (Radio Waves, Infrared, Micro-wave, Satellite).

**Unit 3** **(10 hours)**

**Data Link and MAC Layer:**

Data link layer services, error detection and correction techniques, error recovery protocols (stop and wait, go back n, selective repeat), multiple access protocols with collision detection, MAC addressing, Ethernet..

**Unit 4** **(8 hours)**

**Network layer:**

Networks and Internetworks, virtual circuits and datagrams, addressing, subnetting, Dijkstra Routing algorithm, Distance vector routing, Overview of Network Layer protocols- (ARP, IPV4, ICMP, RARP, IPV6)

**Unit 5** **(10 hours)**

**Transport and Application Layer:**

Process to process Delivery- (client-server paradigm, connectionless versus connection-oriented service); User Datagram Protocols, TCP/IP protocol, Flow Control. FTP (File Transfer Protocol), SMTP (Simple Mail Transfer Protocol), Telnet (Remote login protocol), WWW (World Wide Web), HTTP (HyperText Transfer Protocol), URL (Uniform Resource Locator), DNS, DHCP, BOOTP.

**Essential/recommended readings**

1. Tanenbaum, A.S. & Wethrall, D.J.. Computer Networks, 5th edition, Pearson Education, 2012.

2. Forouzan, B. A.. Data Communication and Networking, 4th edition, McGraw-Hill Education, 2017.

**Additional References**

1. Comer, D. E.. Computer Networks and Internet, 6th edition, Pearson education, 2015.

2. Stallings, W., Data and Computer Communications, 10th edition, Pearson education India, 2017.

**Practicals**.

Introduce students to any network simulator tool and do the following:

1. To Study basic network command and Network configuration commands.

2. To study and perform PC to PC communication.

3. To create Star topology using Hub and Switch.

4. To create Bus, Ring, Tree, Hybrid, Mesh topologies.

5. Perform an initial Switch configuration.

6. Perform an initial Router configuration.

7. To implement Client Server Network.

8. To implement connection between devices using a router.

9. To perform remote desktop sharing within LAN connection.

2. Usage of following commands: cal, cat(append), cat(concatenate), mv, cp, man, date.
3. Usage of following commands: chmod, grep, bc.
4. Write a shell script to display date in the mm/dd/yy format.
5. Write a shell script to display the multiplication table any number.
6. Write a shell script to find the factorial of a given number.
7. Program to show the pyramid of special character "*".
8. Write a shell script to find the sum of digits of a given number.
9. Write a shell script to perform the tasks of basic calculator.
10. Write a shell script to find the power of a given number.
11. Write a shell script to check whether the number is Armstrong or not.
12. Write a shell script to find the GCD (greatest common divisor) of two numbers.
13. Write a shell script to check if the number entered at the command line is prime or not.
14. Write a shell script to display on the screen sorted output of "who" command along with the total number of users.
15. Write a shell script to accept a login name. If not a valid login name display message – "Entered login name is invalid".
16. Write a shell script to compare two files and if found equal asks the user to delete the duplicate file.
17. Write a shell script to merge the contents of three files, sort the contents and then display them page by page.
18. Write a shell script to check whether the file have all the permissions or not.
19. Write a shell script to modify "cal" command to display calendars of the specified months.
20. Write a shell script to modify "cal" command to display calendars of the specified range of months.

## GENERIC ELECTIVES (GE-5b): Advanced Web Programming

### Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **GE5b: Advanced Web Programming** | **4** | **3** | **0** | **1** | Pass in Class XII | Knowledge of HTML, CSS |

### Learning Objectives

The course aims to familiarize the students with the concepts and techniques of server side web programming. This will enable the students to create dynamically generated web pages using HTML, PHP, MySql and JQuery.

## Learning outcomes

On completion of this course, the student will be able to:

- develop interactive and dynamic websites.
- write programs to communicate with the server using GET and POST methods
- learn to connect and manipulate databases using MySql
- validate server-side/backend data

## SYLLABUS OF GE-5b

**Unit 1 (7 hours)**

**Introduction to PHP:** Basic syntax, defining variables and constants, data types including arrays, operators and expressions, decision making statements, constructs for iterations.

**Unit 2 (5 hours)**

**String Handling:** Creating a string and accessing its content, searching and replacing content of a string, and other built-in functions.

**Unit 3 (12 hours)**

**Handling HTML Form with PHP:** Creating a form, submitting data to the server at the backend using GET and POST methods, GET vs POST methods, PHP global functions.

**Unit 4 (15 hours)**

**Database:** Connectivity with MySQL: Connectivity with database, database creation, creating tables, create, retrieve, update, and delete (CRUD) operations

**Unit 5 (6 hours)**

**jQuery and JSON:** Introduction to jQuery syntax (selectors, events, AJAX, JSON).

**Essential/recommended readings**


1. Nixon, R. Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5, O'Reilly, 2018.
2. Holzner S. PHP: The Complete Reference, McGraw Hill, 2017
3. Murach J, Murach's PHP and MySQL, 2nd edition, Mike Murach & Associates, 2014.
4. Duckett, J. JavaScript and JQuery: Interactive Front-End Web Development, Wiley, 2014.


**Additional References**

1. https://www.w3schools.com/php/default.asp

2. https://www.tutorialspoint.com/php/index.htm

**Suggested Practical List : (30 Hours)**

**Practical exercises such as**

1. Write a PHP script to reverse the digits of a number.
2. Create a web page containing two text boxes and a button named "Evaluate". When the user enters numbers in the text boxes and clicks on the "Evaluate" button, a function should evaluate the sum of the numbers and display the result.
3. Write a PHP script to perform following string operations using in-built functions and built an interactive web page having buttons for each of the following operation:
    a. Find the length of a string
    b. Find a substring from a string
    c. Replace text within a string
    d. Remove whitespace and other predefined characters from both sides of a string.
    e. Check if a value is a string
    f. Convert the first character of each word in a string into uppercase.
4. Design a Login form and validate that form using PHP code. Display error message box when data is not valid otherwise redirect to the next page and display "Welcome username!".
5. Design a student registration form, using appropriate input fields consisting of following:
    a. First Name
    b. Last Name
    c. Gender
    d. Roll Number
    e. Phone Number
    f. Course

Submit and retrieve the form data using $_POST, $_GET variable.

6. Write PHP Code to make connection to MySql database, create database and tables and perform insertion, deletion, and retrieval of the data (Using SQL operations like .JOIN, ORDER BY, GROUP BY) Display the messages such as "The record is added in the database!" when data is inserted into the database, "A record is deleted from the database" when data is deleted from the database. Use appropriate button names such as Add Data, Delete Data, and Display Data.

**jQuery and JSON**

1. Change text color and contents using button click events using jQuery
2. Select elements using ID, class, elements name, attribute name
3. Run code on click events in jQuery

4. Handle HTML form, store the data in JSON object, pass them to another page and display it there using jQuery/Javascript

## Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **GE5c: Java Based Web App Development** | **4** | **3** | **0** | **1** | Pass in Class XII | DSC 04 Object Oriented Programming with C++/ GE 1a Programming using C++ / GE1b Programming with Python/ DSC 01 Programming using Python/ GE 3b: Java Programming / A programming course at class XII level |

## Learning Objectives

The course aims to familiarize the students with the concepts and techniques of web app development based on Java. The students will learn about database connectivity, use of HTTP protocol, client side programming, and use of servlets and JSP for server side programming.

## Learning outcomes

On successful completion of this course, students will be able to:

- develop an understand of client-server architecture, HTTP protocol, and web application components.
- connect an application to database and perform basic database operations.
- create servlets and JSP for web applications
- deploy web applications

## SYLLABUS OF GE-5c

### Unit 1 (8 hours)

**Review of Programming Language:** Programming Constructs, Data types, Operators, Concepts of Class, Interface, Inheritance, Exception Handling, Util package, Multithreading, event handling.

9. SVM classification

10. K-Means Clustering

11. Hierarchical Clustering

## DSC16/GE6e/DSE: ARTIFICIAL INTELLIGENCE

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **Artificial Intelligence** | **4** | **3** | **0** | **1** | **Pass in Class XII** | **Programming using C++/Programming using Python/Object Oriented Programming using Python** |

**Course Objectives**

The objectives of this course are to:

- To introduce basic concepts and techniques of Artificial Intelligence (AI).
- To apply informed search techniques for different applications.
- To learn various knowledge representation techniques and writing Prolog programs.
- To learn about the latest techniques for developing AI systems.

**Learning outcomes**

On successful completion of this course, students will be able to:

- identify problems that are amenable to solutions by specific AI methods.
- state the utility of different types of AI agents.
- apply different informed search techniques for solving problems.
- use knowledge representation techniques for AI systems.

**SYLLABUS**

**Unit 1** **6 Hours**

Introduction: Introduction to artificial intelligence, background and applications, Turing test, Weak AI, Strong AI, Narrow AI, Artificial General Intelligence, Super AI, rational agent approaches to AI, introduction to intelligent agents, their structure, behavior and task environment.

**Unit 2** **12 Hours**

Problem Solving and Searching Techniques: Problem characteristics, production systems, control strategies, breadth-first search, depth-first search, hill climbing and its variations, heuristics search techniques: best-first search, A* algorithm, constraint satisfaction problem, means-end analysis, introduction to game playing, min-max and alpha-beta pruning algorithms.

**Unit 3** **16 Hours**

Knowledge Representation: Propositional logic, First-Order Predicate logic, resolution principle, unification, semantic nets, conceptual dependencies, frames, and scripts, production rules, Introduction to Programming in Logic (PROLOG).

**Unit 4** **8 Hours**

Understanding Natural Languages: Components and steps of communication, the contrast between formal and natural languages in the context of grammar, Chomsky hierarchy of grammars, parsing, and semantics, Parsing Techniques, Context-Free and Transformational Grammars, Recursive transition nets.

**Unit 5** **3 Hours**

AI The Present and the Future: Symbolic AI, Data-driven AI and Machine Learning, Introduction to Machine Learning and Deep Learning based AI, Interpretable and Explainable AI, Ethics of AI: benefits and risks of AI.

Essential/recommended readings


1. Russell, Stuart, J. and Norvig, Peter, *Artificial Intelligence - A Modern Approach*, Pearson, 4th edition, 2020..
2. Bratko, Ivan, *Prolog Programming for Artificial Intelligence*, Addison-Wesley, Pearson Education, 4th edition, 2012.
3. Patterson, DAN,W, *Introduction to A.I. and Expert Systems* – PHI, 2007.
4. Clocksin, W., F. and Mellish, *Programming in PROLOG*, 5th edition, Springer, 2003.


Additional references


1. Kaushik, Saroj, *Artificial Intelligence*, Cengage Learning India, 2011.
2. Rich, Elaine and Knight, Kelvin, *Artificial Intelligence*, 3rd edition, Tata McGraw Hill, 2010


Practical List :

Practical exercises such as

1. Write a program in Prolog to implement TowerOfHanoi(N) where N represents the number of disks.
2. Write a program to implement the Hill climbing search algorithm in Prolog.
3. Write a program to implement the Best first search algorithm in Prolog.
4. Write a program to implement A* search algorithm in Prolog.
5. Write a program to implement the min-max search algorithm in Prolog.
6. Write a program to solve the Water-Jug Problem in Prolog.
7. Implement sudoku problem (minimum 9×9 size) using constraint satisfaction in Prolog.
8. Write a Prolog program to implement the family tree and demonstrate the family relationship.
9. Write a Prolog program to implement knowledge representation using frames with appropriate examples.
10. Write a Prolog program to implement conc(L1, L2, L3) where L2 is the list to be appended with L1 to get the resulted list L3.
11. Write a Prolog program to implement reverse(L, R) where List L is original and List R is reversed list.
12. Write a Prolog program to generate a parse tree of a given sentence in English language assuming the grammar required for parsing.
13. Write a Prolog program to recognize context free grammar $a^n b^n$.

2. Select elements using ID, class, elements name, attribute name
3. Run code on click events in jQuery
4. Handle HTML form, store the data in JSON object, pass them to another page and display it there using jQuery/Javascript

## GE6d/DSE: DATA PRIVACY

Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| Data Privacy | 4 | 3 | 0 | 1 | Pass in Class XII | NIL |

**Objective:**

This course aims to provides students with the ability to identify privacy related aspects of data uses, attacks on data privacy, evaluate proposed technical mechanisms for privacy protection and understand ethical issues related to data privacy

**Course Learning Outcomes:**

By the end of this course, students will be able to:

- Understand the basic principles of data privacy and the implications of data breaches.
- Identify and evaluate different methods of protecting sensitive data.

- Explain the role of privacy regulations in safeguarding personal information.
- Implement basic cryptographic techniques to secure data.
- Apply data anonymization techniques to protect personal information.
- Analyze the ethical considerations in data privacy.

**Syllabus**

**Unit 1: Introduction to Data Privacy and Privacy Regulations**

Definition of data privacy, Historical context of data privacy, Types of sensitive data, Privacy laws and regulations

**Unit 2: Data Privacy Attacks, Cryptography and Data Protection**

Type of Attacks/ Data Breaches on Data Privacy, Impact of Data Breaches / Attacks, Introduction to cryptography, Symmetric and asymmetric encryption, Hashing and digital signatures

**Unit 3: Data Collection, Use and Reuse**

Harms Associated with Data collections, use and reuse, Introduction to data anonymization, Data Anonymization Techniques for anonymizing data, Challenges in anonymizing data

**Unit 4: Ethical considerations in Data Privacy**

Privacy and Surveillance, Ethics of Data Collection and Use, Bias and discrimination in data analysis

**References:**

1. Ronald Leenes, Rosamunde van Brakel, and Serge Gutwirth: Data Protection and Privacy: The Age of Intelligent Machines, Hart Publishing, 2017.

2. Naavi: Personal Data Protection Act of India (PDPA 2020) : Be Aware, Be Ready and Be Compliant, 2020.

3. Ravinder Kumar Gaurav Goyal, The Right to Privacy in India: Concept and Evolution, Publisher: Lightning Source, 2016.

**Additional References:**

1. https://onlinecourses.nptel.ac.in/noc22_cs37/preview
2. https://www.coursera.org/learn/northeastern-data-privacy/home/info

**Suggested Practicals:**

Students may be asked to perform some of the following practical activities related to data privacy:

1. Data Privacy Audit: Students can conduct a data privacy audit of a company or organization to identify potential vulnerabilities and risks in their data privacy practices.

2. Privacy Impact Assessment: Students can conduct a privacy impact assessment (PIA) of a new technology or system to identify potential privacy risks and develop strategies to mitigate them.

3. Regulation Compliance: Students can explore the requirements of the Data Protection Regulations and develop a plan for ensuring compliance with the regulation.

4. Cryptography: Students can learn about different cryptographic techniques and tools, such as encryption, hashing, and digital signatures, and implement them in practice.

5. Anonymization Techniques: Students can learn about data anonymization techniques, such as k-anonymity, differential privacy, and data masking, and apply them to a real-world dataset.

6. Privacy Policy Analysis: Students can analyze the privacy policies of different companies and identify gaps or areas for improvement.

7. Privacy-Enhancing Technologies: Students can explore privacy-enhancing technologies (PETs), such as virtual private networks (VPNs), Tor, and secure messaging apps, and evaluate their effectiveness in protecting privacy.

8. Privacy Breach Response Plan: Students can develop a privacy breach response plan for a company or organization, including steps to take in the event of a data breach and strategies for communicating with affected parties.

9. Ethical Considerations: Students can explore ethical considerations in data privacy, such as the balance between privacy and security, the impact of data collection and analysis on marginalized communities, and the role of data ethics in technology development.

10. Case Studies: Students can analyze case studies of privacy breaches or successful privacy protection strategies, and identify key lessons and takeaways.

## DSC17/DSC-A5/GE7c: MACHINE LEARNING

**C**redit distribution, Eligibility and Prerequisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| Machine Learning | 4 | 3 | 0 | 1 | Pass in Class XII | Programming using Python/ bject Oriented Programming using Python |

**Course Objectives**

The course aims at introducing the basic concepts and techniques of machine learning so that a student can apply machine learning techniques to a problem at hand.

**Learning outcomes**

On successful completion of the course, students will be able to:

• Differentiate between supervised and unsupervised learning tasks.

• State the need of preprocessing, feature scaling and feature selection.

• Formulate classification, regression and clustering problems as optimization problems

• Implement various machine learning algorithms learnt in the course.