MCAE309: DIGITAL IMAGE PROCESSING [3-0-1]

Course Objectives: The course aims to cover core concepts in digital image processing. The course begins with the image enhancement techniques in the spatial and frequency domain, followed by the image morphological operations such as dilation, erosion, and hit-or-miss transformations. The course also covers image segmentation and image compression.

Course Learning Outcomes :

Upon successful completion of this course, a student will be able to:

CO1 compare different techniques of image acquisition, enhancement, compression and segmentation.
CO2 choose appropriate feature extraction technique for an application..
CO3 compare and contrast merits of different image compression techniques
CO4 implement various image processing techniques.

Syllabus:

Fundamental Steps in Image Processing: Element of visual perception, a simple image model, sampling and quantization, some basic relationships between pixel, image geometry in 2D, image enhancement in the spatial domain.

Introduction to spatial and frequency methods: Basic gray level transformations, histogram equalization, local enhancement, image subtraction, image averaging, basic spatial, filtering, smoothing spatial filters, sharpening spatial filters.

Introduction to the Fourier transformation: Discrete fourier transformation, fast Fourier transformation, filtering in the frequency domain, correspondence between filtering in the spatial and frequency domain smoothing frequency-domain filters, sharpening frequency-domain filters, homomorphic filtering,

Some basic morphological algorithms: Line detection, edge detection, gradient operator, edge linking and boundary detection, thresholding, region-oriented segmentation, representation schemes like chain codes, polygonal approximations, boundary segments, skeleton of a region.

Introduction to Image Compression: JPEG, MPEG, Wavelets

Readings:

1. Rafael C. Gonzalez and Richard E.Woods, **Digital Image Processing**, Prentice–Hall of India, 2002
2. William K. Pratt, **Digital Image Processing: PIKS Inside** (3rd ed.), John Wiley & Sons, Inc., 2001
3. Bernd Jahne, **Digital Image Processing**, (5th revised and extended edition), Springer, 2002
4. S. Annadurai and R. Shanmugalakshmi, **Fundamentals of Digital Image Processing**, Pearson Education, 2007
5. M.A. Joshi, **Digital Image Processing: An Algorithmic Approach**, Prentice-Hall of India, 2006
6. B. Chanda and D.D. Majumder, **Digital Image Processing and Analysis**, Prentice-Hall of India, 2007

CO3: use software tools to simulate and analyze different CPS systems.

CO4: plan, implement, and monitor cyber security mechanisms to protect information technology assets.

Syllabus:

Unit-I: Introduction: Examples of cyber physical systems (CPS) in different domains, Important design aspects and quality attributes of CPS, Finite state machine, Characteristics of high confidence CPS,

Unit-II: Modeling of CPS: Discrete System Modelling, Continuous systems modelling, Extended state machines, Modelling of Hybrid systems, Various classes of Hybrid Systems, Analysis and Verification, Concepts of embedded systems, Input-outputs, Invariants and Temporal Logic, Linear Temporal Logic, Refinement and Equivalence, Model Development, Rechability Analysis and Model Checking, simulations.

Unit-II: Security of CPS: Cyberspace, Internet of things, Cyber Crimes, Cyber Security, Cyber Security Threats, Cyber laws and legislation, Law Enforcement Roles and Responses. Network Threat Vectors, MITM, OWAPS, ARP Spoofing, IP & MAC Spoofing, DNS Attacks, SYN Flooding attacks, UDP ping-pong and Fraggle attacks, TCP port scanning and reflection attacks, DoS, DDOS. Network Penetration Testing Threat assessment, Penetration testing tools, Penetration testing, Vulnerability Analysis, Threat matrices, Firewall and IDS/IPS, Wireless networks, Wireless Fidelity (Wi-Fi), Wireless network security protocols, Nmap, Network fingerprinting, BackTrack, Metasploit.

Readings:

1. R. Rajkumar, D. de. Niz and M. Klein, **Cyber Physical Systems,** Addision-Wesely, 2017

2. Rajiv Alur, **Principles of Cyber-Physical Systems**, MIT Press, 2015.

3. E.A.Lee and S A Shesia, **Embedded system Design: A Cyber-Physical Approach,** Second Edition, MIT Press, 2018

4. A. Platzer, **Logical Foundations of Cyber Physical Systems,** Springer, 2017.

5. Peter W. Singer and Allan Friedman, Cybersecurity and Cyberwar, Oxford University Press, 2014

6. Jonathan Clough, Principles of Cybercrime, Cambridge University Press, 2015

MCSE302: GRAPH THEORY

Course Objectives: This course will introduce the basic concepts of graphs theory, graph properties and formulations of typical graph problems. The student will learn to model real-life problems such as graph coloring and connectivity as graph problems.

Course Learning Outcomes :

Upon successful completion of this course, a student will be able to:

CO1: model real-life problems using different types of graphs like trees, bipartite graphs and planar graphs.
CO2: identify special graphs like Euler graphs and Hamiltonian graphs.
CO3: identify various forms of connectedness in a graph
CO4: examine different graph-coloring problems and their solutions.
CO5: model simple problems from real life as graph-coloring problems.

Syllabus:

Introduction: Examples of problems in graph theory, adjacency and incidence matrices, isomorphisms, paths, walks, cycles, components, cut-edges, cut-vertices, bipartite graphs, Eulerian graphs, vertex degrees, reconstruction conjecture, extremal problems, degree sequences, directed graphs, de Bruijn cycles, orientations and tournaments.

Trees: Trees and forests, characterizations of trees, spanning trees, radius and diameter, enumeration of trees, Cayley's formula, Prüfer code, counting spanning trees, deletion-contraction, the matrix tree theorem, graceful labelling, minimum spanning trees (Kruskal's algorithm), shortest paths (Dijkstra's algorithm).

Matching and Covers: Matchings, maximal and maximum matchings, M-augmenting paths, Hall's theorem and consequences, Min-max theorems, maximum matchings and vertex covers, independent sets and edge covers,Connectivity, vertex cuts, Edge-connectivity.

Connectivity and Paths: Blocks, k-connected graphs, Menger's theorem, line graphs, network flow problems, flows and source/sink cuts, Ford-Fulkerson algorithm, max-flow min-cut theorem.

Graph Coloring: Vertex colorings, bounds on chromatic numbers, chromatic numbers of graphs constructed from smaller graphs, chromatic polynomials, properties of the chromatic polynomial, the deletion-contraction recurrence.

Planar Graphs: Planar graphs, Euler's formula, Kuratowski's theorem, five and four color theorems.

Readings:

1. Douglas B West, **Introduction to Graph Theory**, Pearson, Second Edition, 2017.
2. Gary Chartrand and Ping Zhang, **Introduction to Graph Theory**, Tata McGraw Hill, 2017.
3. Jonathan L. Gross and Jay Yellen, **Graph Theory and Its Applications**, Chapman Hall (CRC), Second Edition, 2005.