DEPARTMENT OF COMPUTER SCIENCE & APPLICATIONS
MAHARSHIDAYANANDUNIVERSITY,ROHTAK

SCHEME ANDSYLLABI FOR Ph.D COURSE WORK (COMPUTER SCIENCE)
FOR
DOCTOR OF PHILOSOPHY (Ph.D) IN COMPUTER SCIENCE
(w.e.f.theSession2023-24)

Program Specific Outcomes:

The students upon completion of Ph.D (Computer Science) Course Work program will be able to:

PSO1 Produce a well-developed research proposal and select an appropriate methodology with which to conduct the research and defend the methodology of their selection.
PSO2 Understand the various tasks required to carry out the research.
PSO3 Find the resources needed to perform the research process.
PSO4 Documentation and its find in gsin the individual research area.
PSO5 Understand the most advanced research in the candidate's specialization area of Computer Science respectively

Duration: One Semester (Six months)

TotalCredits:14credits

Semester-1							
S.No	**Course Code**	**Course Title**	**External Marks**	**Internal Marks**	**Total Marks**	**Hours per Week**	**Credits**
1.	23CSAPH11C1 (Compulsory)	Research Methodology & Its Relevance in Computer Science	70	30	100	4Hours	4
2.	23CCPH11C1 (Compulsory for all Ph.D. Course Work)	Research and Publication Ethics	35	15	50	2Hours	2
3.	23CSAPH11C3	Elective-1	70	30	100	4Hours	4
4.	23CSAPH11C4	Elective-2	35	15	100	4Hours	2
	Total Marks				**350**		**12**

Note:

1) ***The compulsory course on 'Research and Publication Ethics' shall be offered by Chaudhary Ranbir Singh Institute of Social and Economic Change.***

2) ***Each course shall have an internal assessment of 30 %. It shall comprise of two written assignments (7.5 % each) and two presentations (7.5 % each). The concerned teacher/Head of the Department shall maintain the record for at least six months after the declaration of results.***

List of Electives Papers

Students can choose any one of the elective papers from each of the following categories:

Elective-1	
EL-1.1	Data Warehousing and Mining
EL-1.2	Mobile Computing
EL-1.3	Big Data Analytics
EL-1.4	Web Analytics &Intelligence
EL-1.5	Computer Vision and Image Processing
Elective-2	
EL-2.1	Software Testing and Quality Assurance
EL-2.2	Ad Hoc and Sensor Networks
EL-2.3	Software Design and Engineering
EL-2.4	Information Security
EL-2.5	Machine Learning and Python Programming

Note: *More Elective Papers may be added from time to time depending upon the availability of the Expertise in the Department and its suitability for the researchers.*

Subject: RESEARCH METHODOLOGY & ITS RELEVANCE IN COMPUTER SCIENCE (23CSAPH11C1)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Research Methodology & Its Relevance in Computer Science	**Course Code**	23CSAPH11C1
Hours/Week	4	**Credits**	4
Max. Marks.	70	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt
One question each from each unit along the compulsory question(5x14=70marks)

Course Objectives:

1. Understand some basic concepts of research and its methodologies
2. Select and define appropriate research problem and parameters
3. Prepare a project proposal(to undertake a project)
4. Organize and conduct research (advanced project) in a more appropriate manner
5. Write a research report and thesis

Course Outcomes:

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

1. Learn the concept of research, research process, types of research, research models and basics formats of report writing.
2. Learn the use of statistical analytic techniques for data analysis and testing of hypothesis
3. Identify the differences between measurement and scaling and how sample is selected and determined using various approaches.
4. Understand sources of data collection and how data is collected from different sources.
5. Understand the concept of interpretation and role of computer in mathematical and statistical analysis with applications of relevant research methodologies used in computer science.

Unit– I

Introduction to Research: Types, Research process and steps in it, Hypothesis, Research proposals and aspects. Research Design: Need, Problem Definition, variables, research design concepts, Literature survey and review, Research design process, Errors in research.

Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling. Report Writing: Pre writing considerations, Thesis writing, Formats of report writing, formats of publications in Research journals.

Unit–II

Design of Experiments: Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles-replication, randomization, blocking, Guidelines for design of experiments; Single Factor Experiment: Hypothesis testing, Analysis of Variance (ANOVA) components for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking, Chi-Square Test.

Two factor Factorial Design, Basic definitions and principles, main effect and interaction, responses face and contour plots, General arrangement for a two-factor factorial design; Models-Effects,means and regression, Hypothesis testing.

Unit– III

Measurement and scaling Techniques: Measurement: concept, Levels and components of Measurement, Techniques of Developing Measurement Tools, sources of Error in measurement, Tests of Sound Measurement. Scaling: Meaning of Scaling, Bases of Scales-classification, important scaling techniques-Rating and Ranking. Approaches of the scale construction, different types of scales-Arbitrary Scales, Differential Scales, Summated Scales, Cumulative Scales, factor Scales.

Sampling: Sampling Theory, Sandler's A-test, Concept of standard errors, Estimating Population mean (μ), Sample size and its Determination.

Unit– IV

Qualitative Research: Themes of qualitative Research, Research Strategies; Data collection Techniques, combining qualitative and quantitative research.

Data Analysis and Interpretation of Data: Data Analysis: Paramedic and Nonparametric data, Descriptive and Inferential Analysis. Interpretation of Data: Forms of Interpretation, Prerequisites for Interpretation, Precautions in Interpretation, conclusions and Generalizations, sources of Errors in Interpretations, Mathematical and statistical analysis using software tools like MAT Lab, SPSS or free wares tools. The computer: Its role in research.

Suggested Readings:

1) Montgomery, Douglas C.Design and Analysis of Experiments (John Wiley & Sons).
2) Montgomery, Douglas C. & Runger, George C. Applied Statistics& Probability for Engineers (Wiley India)
3) Kothari C.K. Research Methodology- Methods and Techniques (New Age International, New Delhi)
4) Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
5) The complete reference Office Xp–Stephan L.Nelson,GujuliaKelly(TMH).
6) Any other book(s) covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time.

Subject: RESEARCH AND PUBLICATION ETHICS
(23CCPH11C1)

(Compulsory for all Ph.D. Course Work)

Syllabus of Research and Publication Ethics shall be provided by Chaudhary Ranbir Singh Institute of Social and Economic Change.

Elective-I Paper:
EL-1.1 DATA WARE HOUSING AND MINING
(23CSAPH11C3)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Data Warehousing and Mining	**Course Code**	23CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	70	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt
One question each from each unit along the compulsory question(5x14=70marks)

Course Objectives:

1. Know about classification of data mining system and data processing.
2. Learn data Warehouse and OLAP Technology for data mining
3. Understand various data mining functionalities
4. Inculcate knowledge on data mining uery languages.
5. Know in detail about data mining algorithms

Course Outcomes:

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

1. Identify the need of Data Warehouse System and its benefits.
2. Preprocess the Input data set by applying different pre-processing approaches.
3. Perform data analysis by selecting the most appropriate attributes.
4. Analyze and evaluate the data mining results by using different performance evaluators.
5. Present the derived results by using different presentation tools.

Unit– I

Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Data Mining Task Primitives, Integration of a Data Mining System with a Database or a Data Warehouse System, Major issues in Data Mining.

Data Preprocessing: Need for Preprocessing; the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation.

Unit–II

Data Warehouse and OLAP Technology for Data Mining: Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Further Development of Data Cube Technology, From Data Warehousing to Data Mining Different types of Cubes and Data Generalization: Further Development of Data Cube and OLAP Technology, Attribute-Oriented Induction.

Unit– III

Mining Frequent Patterns, Associations and Correlations: Basic Concepts, Efficient and Scalable Frequent Item set Mining Methods, Mining various kinds of Association Rules, From AssociationMiningtoCorrelationAnalysis,Constraint-BasedAssociationMining.

Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Classification by Back propagation, Support Vector Machines, Associative Classification, Lazy Learners, Other Classification Methods, Prediction, Accuracy and Error measures, Evaluating the accuracy of a Classifier or a Predictor, Ensemble Methods.

Unit– IV

ClusterAnalysisIntroduction: TypesofDatainClusterAnalysis,ACategorizationofMajor Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-Based Methods,Grid-Based Methods, Model-Based Clustering Methods. Introduction to different applications of Data Mining: Time Series and Sequence Data Mining, Graph Mining, Social Network Analysis, Spatial Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web. Additional Themes on Data Mining and Social Impacts of Data Mining.

Suggested Readings:

1) Data Mining – Concepts and Techniques - Jiawei Han & Micheline Kamber, Morgan Kaufmann Publishers.
2) Introduction to Data Mining – Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Pearson education.
3) Data Warehousing in the RealWorld – Sam Aanhory & Dennis Murray Pearson Edn Asia.
4) Data Warehousing Fundamentals–Paulraj Ponnaiah Wiley student Edition
5) TheDataWarehouseLifecycleToolkit–RalphKimballWileyStudentEdition.
6) Any other book(s)covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time.

Elective-1 Paper:
EL-1.2 MOBILE COMPUTING
(23CSAPH11C3)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Mobile Computing	**Course Code**	23CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	70	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt
One question each from each unit along the compulsory question (5x14=70marks)

Course Objectives:

1. Learn Network Technologies and Cellular Communication
2. Know medium access control and mobile network ayer
3. Learn the concept of mobile transport ayer.
4. Know the various database issues in mobile computing.
5. Learn the concept of Mobile ad hoc network.

Course Outcomes:

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

1 Describe the basic concepts and principles in mobile computing.

2 Understand the concept of Wireless LANs, PAN, Mobile Networks, and Sensor Networks.

3 Understand positioning techniques and location-based services and applications and describe the important issues and concerns on security and privacy.

4 Apply the fundamental design paradigms and technologies to mobile computing applications and Explain the structure and components for Mobile IP and Mobility Management

5 Appraise the quality and performance of mobile applications, MANET and assess and implement security principles in mobile applications.

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Unit– I

Network Technologies and Cellular Communications: HIPERLAN: Protocol architecture, physical layer, Channel access control sub-layer, MAC sub-layer, Information bases and networking. WLAN**:** Infraredvs. Radiotrans mission, Infrastructure and adhoc networks, IEEE 802.11.

Bluetooth: User scenarios, Physical layer, MAC layer, Networking, Security, Link management

GSM: Mobile services, System architecture, Radio interface, Protocols, Localization and calling, Handover, Security, and New data services.

Mobile Computing (MC): Introduction to MC, novel applications, limitations, and architecture

Unit–II

Wireless) Medium Access Control: Motivation for a specialized MAC (Hidden and exposed terminals, near and far terminals); SDMA, FDMA, TDMA, CDMA;

Mobile Network Layer: Mobile IP: Goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunneling and encapsulation, optimizations, Dynamic Host Configuration Protocol (DHCP).

Unit– III

MobileTransportLayer: TraditionalTCP,IndirectTCP,SnoopingTCP,MobileTCP,Fast retransmit/ fast recovery, Transmission/time-out freezing, Selective retransmission, Transaction oriented TCP.

Database Issues: Hoarding techniques, caching invalidation mechanisms; client server computing with adaptation; power-aware and context-aware computing; transactional models, query processing, recovery, and quality of service issues.

Unit– IV

Data Dissemination: Communications asymmetry: Classification of new data delivery mechanisms, push based mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques.

Mobile Ad hoc Networks (MANETs): Overview, Properties of a MANET, spectrum of MANET applications, unicast and multicast routing algorithms, DSR, AODV, OLSR, CEDAR, ODMRP Protocols and Tools: security in MANETs, Wireless Application Protocol-WAP: Introduction, protocol architecture, and treatment of protocols of all layers. Bluetooth: User scenarios, physical layer, MAC layer, networking, security, link management) and J2ME.

Suggested Readings:

1) Jochen Schiller,"MobileCommunications",*PearsonEducation*.
2) Rajkamal, Mobile Computing, OXFORDUniversity Press
3) Asoke Talukder, Roopa Yavagal "Mobile Computing",Tata McGrawHill
4) Reza Behravanfar ,"Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML", Cambridge University Press.
5) C.Siva Rammurthy, B.S. Manoj, Adhoc wireless networks, architectures and protocols. Pearson education.
6) Any other book(s) covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time.

Elective-1 Paper:
EL-1.3 BIG DATA ANALYTICS
(23CSAPH11C3)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Big Data Analytics	**Course Code**	23CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	70	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt
One question each from each unit along the compulsory question(5x14=70marks)

Course Objectives:

1. Learn the basic concept of data analytics.
2. Know the big data technology and bid data analytics
3. Learn the concept of business intelligence.
4. Know the concept of Hadoop.
5. Learn how to implement the concept of big data.

Course Outcomes:

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

1. To classify, visualize and forecast the data after analysis.
2. Perform the predictive analysis on the Big Data by using Hadoop.
3. Differentiate between the Online analytical processing & Online transactional processing.
4. Perform statistical analysis of Big Data using Rsoftware.
5. Implement the Big Data on Cloud and to provide security to Big Data.

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Unit– I

Introduction to Data Analytics: Data and Relations, Data Visualization, Correlation, Regression, Forecasting, Classification and Clustering.

Big Data Technology: Fundamentals of Big Data, Types, Big Data Technology Components, Big Data Architecture, Big Data Warehouse, Functional vs Procedural Programming Models for big data.

Unit–II

Big Data Analytics: Introduction to Big Data Analytics, Framework for Big Data Analysis, Approaches for big data analysis, ETL in Big Data. Understanding Text Analytics and Big Data, Predictive Analysis on Big Data, Role of Data Analyst. Introduction to Hadoop Ecosystem: HDFS, Map reduce programming.

Unit– III

Business Intelligence: Introduction to Business Intelligence, Business View of IT Applications, Digital Data, Introduction to Online Analytical Processing & OLAP vs OLTP. Business Intelligence Concepts: BI roles and responsibilities, BI framework and components, BI Project life cycle, Business Intelligence vs Business Analytics.

Unit– IV
Implementation of Big Data: Big data implementation: Big data workflow. Variant data types: Operational data bases, Graph databases in big data environment, Real Time Data Stream and Complex Event Processing. Introduction to Statistical Analysis with R Software.Big Data Computation and its limitations. Applications of Big data: Business Scenario, Big data on Cloud and Security and Governance of Big data.
Suggested Readings: 1) Minelli M., ChambersM., DhirajA., Big Data, BigAnalytics: Emerging Business Intelligence and Analytic Trends for Today's Business. Wiley. 2) Viktor Mayer-Schonberger, Kenneth Cukier, Big Data: A Revolution that willtransform how we live, work and think. 3) Big Data Black Book by DTE ditorial Services, Dreamtech Publications. 4) SeemaAcharya&SubhashiniChellappan,Big data and Analytics, Wileypublishers. 5) A.K.Pujari: Data Mining Techniques,UniversityPress. 6) Any other book(s) covering the contents of the paper in more depth. . **Note: Latest and additional good books may be suggested and added from time to time.**

Elective-1Paper:
EL-1.4 WEB ANALYTICS AND INTELLIGENCE
(23CSAPH11C3)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Web Analytics And Intelligence	**Course Code**	23CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	70	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt
One question each from each unit along the compulsory question(5x14=70marks)

Course Objectives:

1. Learn the concept of Web Analytics and Intelligence
2. Know about weblog, web beacons and packet sniffing.
3. Learn about Heuristic evaluations
4. Know about Web Analytic fundamentals
5. Understand the concept of Google Analytics

Course Outcomes:

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

1 Characterize the web data as visit or content type.
2 Understand to apply the conversion metrics offline as well as online web.
3 Collect the data of different kinds: web logs, web beacons and stream data.
4 Create packets and to perform the packet sniffing, identification of unique page.
5 Apply different metrics to count hits, views, bounce and to generate different kinds of reports.

Unit– I

Introduction: Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, On site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations.

Data Collection: Click stream Data: Web logs, Web Beacons,J ava Scripttags,Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP- based measurement, Search Engine data.

Unit–II

Qualitative Analysis: Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys.

Web Analytic fundamentals: Capturing data: Web logs or JavaScript's tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding click stream data quality, Identifying unique page definition, Using cookies, Link coding issues.

Unit– III

Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing Ad Words campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI.

Relevant Technologies: Internet& TCP/IP, Client /Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

Unit– IV

WebAnalytics2.0:Webanalytics1.0,Limitationsofwebanalytics1.0,Introductiontoanalytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities.

Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Suggested Readings:

1) CliftonB.,AdvancedWebMetricswithGoogleAnalytics,WileyPublishing,Inc.
2) Kaushik A.,Web Analytics2.0, The Art of Online Account ability and Science of Customer Centricity, Wiley Publishing, Inc.
3) Sterne J.,Web Metrics: Proven methods for measuring web site success, Johnv Wiley and Sons
4) WebAnalytics2.0byAvinashKaushik.
5) Web Analytics anhoura Day by Avinash Kaushik.
6) Any other book(s) covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time.

Elective-1 Paper:
EL-1.5 COMPUTER VISION AND IMAGE PROCESSING
(23CSAPH11C3)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Computer Vision and Image Processing	**Course Code**	23CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	70	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt
One question each from each unit along the compulsory question(5x14=70marks)

Course Objectives:

1. Understand Core Concepts of Computer Vision and Image Processing.
2. Master Image Processing Techniques and Algorithms.
3. Develop Skills in Implementing Computer Vision Algorithms.
4. Apply Computer Vision Techniques to Real-World Applications.
5. Gain Hands-On Experience through Projects and Practical Assignments.

Course Outcomes:

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

1. Understand the fundamental of Computer vision and Machine Learning for Computer vision.
2. Understand the foundation of Image Processing and concepts of Image enhancement
3. Understand the concepts of Image rest oration and feature extraction.
4. Know about segmentation and compression of image.
5. Develop computer image processing program sand applications using Open CV-Python Libraries.

Unit– I

Computer Vision: Concepts of Computer vision, Computer vision vs Image Processing, Geometric techniques in Computer vision- Image transformations, Camera projections, Camera calibration, Depth from Stereo, Two view structure from motion, Object tracking.

Machine Learning for Computer Vision: Introduction to Machine learning, types of Machine Learning; Image Classification: Supervised and Unsupervised Image classification, Algorithms for Image classification; Object detection: Concepts of Object detection, Methods of Object detection; Image Segmentation: Classes of segmentation, Types of segmentation, Methods of segmentation.

Unit–II

Image Processing Foundations: Review of image processing techniques – classical filtering operations –thresholding techniques – edge detection techniques – corner and interest point detection – mathematical morphology– texture.

Shapes and Regions: Binary shape analysis–connectedness–object labelling and counting–size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary trackingprocedures–activecontours–shapemodelsandshaperecognition–centroidalprofiles–handlingocclusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors–moments.

Image Enhancement: Spatial and Frequency domain-Histogram processing-Spatial filtering-SmootheningspatialfiltersSharpeningspatialfilters-DiscreteFourierTransform-DiscreteCosineTransform-HaarTransform-HoughTransform-Frequency filtering-Smoothening frequency filters-Sharpening frequency filters-Selectivefiltering.

Unit– III

Image Restoration & Image Registration: Noise models - Degradation models-Methods to estimate the degradation-Image de-blurring Restoration in the presence of noise only spatial filtering-Periodic noise reduction by frequency domain filtering-Inverse filtering-Wiener Filtering. Geometrical transformation- Point based methods- Surface based methods-Intensity based methods

Feature Extraction: Region of interest (ROI) selection - Feature extraction: Histogram based features - Intensity features-Color, Shape features-Contour extraction and representation-Homogenous region extraction and representation-Texture descriptors - Feature Selection: Principal Component Analysis (PCA).

Image Segmentation: Discontinuity detection-Edge linking and boundary detection. Thresholding-Region oriented segmentation- Histogram based segmentation. Object recognition based on shape descriptors. Dilation and Erosion-Opening and Closing-Medial axis transforms-Objects skeletons-Thinning boundaries.

Unit– IV

Image Coding & Compression: Lossless compression versus lossy compression-Measures of the compression efficiency- Huf manncoding- Bitplanecoding-Shiftcodes-Block Truncationcoding- Arithmeticcoding- Predictive coding techniques-Lossy compression algorithm musingthe2- D.DC Ttransform-The JPEG2000 standard Base linelossy JPEG, based on DWT.

Open CV: Installation of Open CV-Python, Open CV Standard Images and Data Sets, Python for IPCV,Python for Image Processing, Contrast Stretching, Linear Filtering, Histogram Equalization, Gaussian Convolution, Separable Gaussian Convolution, Gaussian Derivatives, Comparison of theory and practice, Canny Edge Detector, Histogram of Oriented Gradients, Preprocessing, Calculate the Gradient Images, Calculate HOG in 8x8 Cells, Block Normalization, Calculate the HOG feature vector, Visualizing the HOG.

Suggested Readings:

1. D.L.Baggio etal.:Mastering Open CV with Practical Computer Vision Projects ǁ, Packt Publishing.
2. Jan Erik Solem:Programming Computer Vision with Python: Tools and algorithms for analyzing images, O'Reilly Media.
3. Mark Nixon and Alberto S.Aquado: Feature Extraction & Image Processing for Computer Visionǁ, Third Edition, AcademicPress.
4. R.Szeliski: Computer Vision:Algorithms and Applications ǁ, Springer.
5. SimonJ. D.Prince: Computer Vision: Models, Learning, and Inferen ceǁ, Cambridge University Press.
6. Richard Szeliski ,Computer Vision: Algorithms and Applications (Texts in Computer Science) 2nded. 2022Edition
7. E.R.Davies: Computer and Machine Vision: Theory, Algorithms and Practicalities.
8. Valliappa Lakshmanan, Martin Görner: Practical Machine Learning for Computer Vision: End-to-End Machine Learning for Images, O'reilly
9. Forsyth Ponce, Computer Vision: AModern Approach (2nd Edition), Pearson Publication.
10. Alberto Fernández Villán: Mastering Open CV4 with Python, Packt Publication.
11. David Millán Escrivá, Robert Laganiere: OpenCV4 Computer Vision Application Programming Cookbook- Fourth Edition, Packt Publication
12. Any other book(s) covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time.

Elective-II Paper:
EL-2.1 SOFTWARE TESTING AND QUALITY ASSURANCE
(23CSAPH11C4)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Software Testing and Quality Assurance	**Course Code**	23CSAPH11C4
Hours/Week	2	**Credits**	2
Max. Marks.	50	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one Compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 7 = 35 marks)

Course Objectives:

1. Know the concept of functional testing
2. Learn about object oriented testing
3. Understand the basic concept of software quality
4. Know about various software testing tools
5. Know about software Quality standards

Course Outcomes:

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

1. Knowledge of various Software Testing techniques.
2. Use Software Testing Strategies and Metrics for Software testing.
3. Knowledge of Object Oriented Testing strategies.
4. Knowledge of Software Reliability, and Software Quality Assurance.
5. Knowledge of Quality management standards and methods.

Unit– I

A perspective on Testing, STLC, Functional testing: Boundary value testing, Equivalence ─ class testing, Decision Table Testing etc., Retrospective on Functional Testing; Structural testing: path testing, data flow testing, mutation testing, etc. Retrospective testing, Levels of testing: Integration testing, system testing, acceptance testing, stress testing, Regression testing-β testing.

Unit–II

Object-oriented Testing, Interaction testing, Testing of Web Applications, Testing metrics, Testing Paradigms: Scripted testing, Exploratory testing, Test planning, Supporting Technologies: Defect taxonomies, Testing tools and standards, Case studies.

Unit– III

Introduction to Software Quality, Quality Models: McCall's Model, Hierarchical model FCMM, Measuring Software Quality, Quality Metrics: Process, Product, Quality Control Tools, Quality assurance concept, importance, Requirements for SQA works.

Unit– IV

Pareto Principle to SQA, Costs of Software Quality, SQA metrics, Audit Review, Walk through, Inspection techniques, SQA plan., Quality standards: SEI-CMM, ISO 9000 series, comparison between SEI CMM and ISO 9000.

Suggested Readings:

1. A Practitioner's Guide to Test Case Designby LEE Copland, Artech House Publishers, Boston - London.
2. Software Testing–A Craft's man Approach, Paul C. Jorgensen, ACRC Press LLC.
3. Software Engineering (Software Testing, Reliability and Quality Assurance), Gill Nasib Singh, Khanna Book Publishing Co.(P) Ltd, N. Delhi.
4. Software Quality Theory and Management by AlanC. Gillies, Chapman &Hall.
5. Software Quality by Galrry S.Marliss, Thomson.
6. Metrics and Models in Software Quality Engineering by Stephen H. Kan , Pearson Education.
7. Any other book(s) covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time.

Elective-II Paper:
EL-2.2 ADHOC AND SENSOR NETWORKS

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Adhoc and Sensor Networks	**Course Code**	23CSAPH11C4
Hours/Week	2	**Credits**	2
Max. Marks.	50	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one Compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 7 = 35 marks)

Course Objectives:

1. Know about Adhoc And Sensor Networks
2. Understand the criteria of Routing in MANET
3. Learn about data transmission
4. Understand the basics of Wireless, Sensors and Applications
5. Learn the concept of Data Retrievalin Sensor Networks

Course Outcomes:

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

1. Understand the needs of Wireless Adhoc and Sensor Network in current scenario of technology.
2. Describe current technology trends for the implementation and deployment of wireless Adhoc/sensor networks.
3. Discuss the challenges in designing MAC, routing.
4. Transport protocols for wireless Ad-hoc/sensor networks.
5. Explain the principles and character is tics of wireless sensor networks

Unit– I

Introduction to Ad Hoc Networks: Characteristics of MANETs, Applications of MANETs and challenges of MANETs - Routing in MANETs: Criteria for classification, Taxonomy of MANET routing algorithms, Topology based routing algorithms, Position based routing algorithms,Other routing algorithms.

Unit–II

Data Transmission: Broadcast storm problem, Broadcasting, Multicasting and Geo casting. TCP over Ad Hoc: TCP protocol overview, TCP and MANETs, Solutions for TC Pover Ad hoc

Unit– III

Basics of Wireless, Sensors and Applications: Applications, Classification of sensor networks, Architecture of sensor network, Physical layer, MAC layer, Link layer.

Unit– IV

Data Retrieval in Sensor Networks: Routing layer, Transport layer, High-level application layer support; Adapting to the inherent; dynamic nature of WSNs; Sensor Networks and mobile robots. Security: Security in Ad Hoc networks, Key management, Secure routing, Cooperation in MANETs, Intrusion Detection systems.

Sensor Network Platforms and Tools: Sensor Network Hardware, Berkeleymotes, Sensor Network Programming Challenges, Node-Level Software Platforms - Operating System: Tiny OS –Imperative Language**:** nesC, Dataflow style language: Tiny GALS, Node-Level Simulators, NS-2 and its sensor network extension, TOSSIM.

Suggested Readings:

1. Ad Hoc and Sensor Networks– Theory and Applications, Carlos Corderioharma P. Aggarwal, World Scientific Publications.
2. Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, Leonidas Guibas, Elsevier Science. (Morgan Kauffman Series)
3. Wireless Ad Hoc and Sensor network: Protocol, performance and controlby Jagannathan Sarangapani, CRC Press.
4. Wireless AdHoc and Senseor Network by H Labiod, Wiley.
5. Any other book(s) covering the contents of the paper in more depth..

Note: Latest and additional good books may be suggested and added from time to time

Elective-II Paper:
EL-2.3 SOFTWARE DESIGN AND ENGINEERING

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Software Design and Engineering	**Course Code**	23CSAPH11C4
Hours/Week	2	**Credits**	2
Max. Marks.	50	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one Compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 7 = 35 marks)

Course Objectives:

1. Know about process models
2. Learn the concept of software design
3. Understand about Designing with objects and components
4. Learn the concept of transferring design knowledge
5. Know about Project Scheduling and Risk Management

Course Outcomes:

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

1. Appreciate the engineering nature of software development
2. Describe key activities in software development and the role of modeling
3. Explain key concepts in software development such as risk and quality
4. Explain the basics of an object-oriented approach to software development
5. Describe a simple work flow for interacting with the published literature on software development.

Unit– I

Introduction to Software Engineering: The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering-A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models.

Process models: The waterfall model, Incremental process models, Evolutionary process models, specialized process models, The Unified process. Software Requirements: Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management.

Unit–II

Role of Software Design: The nature of the design process; transferring design knowledge; constraints upon the design process and product, recording design decisions, designing with others, context for design, economic factors, assessing design qualities, quality attributesof the design product, assessing the design process.

TransferringDesignKnowledge-Representingabstractideas;designviewpoints,thearchitecture concept, design methods, design patterns, Design representations, and rationale for design

methods. Design Processes and Strategies: The role of strategy in design methods, describing the design process–The D –Matrix, design by top-down de composition, design by composition and organizational in fluences upon design.

Unit– III

Designing with objects and components : Designing with objects: design practices for object-oriented paradigm, Object- oriented frame works, Hierarchal object oriented design process and heuristics, the fusion method, the unified process. Component –based design: The component concept, designing with components, designing components, COTS, Performing User interface design-The Golden rules, Interface analysis and design models, user and task analysis, analysis of display content and work environment, applying interface design steps, user interface design issues, design evaluation.

Unit– IV

Project Management and Metrics: Project Management: The management spectrum: people, product, process and project, W5HH principle, critical practices. Metrics for Process and Projects: Process metrics, project metrics, size-oriented metrics, function oriented metrics, Object-oriented and use-case metrics, metrics for software quality, integrating metrics within the software process.

Project Scheduling and Risk Management: Project Scheduling: Basic concepts, project scheduling, defining a task set and task network, timeline Charts, tracking the schedule, tracking the progress for an OO project, Earned value analysis. Risk Management: reactive vs. Proactive risk strategies, software risks, risk identification, risk Projection, risk refinement, risk mitigation and monitoring, the RMMM plan.

Suggested Readings:

1. Software Engineering (Software Testing, Reliability and Quality Assurance), Gill Nasib Singh, Khanna Book Publishing Co.(P) Ltd, N. Delhi.
2. Software design, David Budgen, Pearson education.
3. Software Engineering: Apractitioner's Approach, Roger S Pressman, seventh edition Mc- Graw Hill International Edition.
4. Software Engineering, Ian Sommerville, Pearson Education.
5. Software Project Management, Bob Hughes& Mike Cotterell, Tata Mc-Graw Hill.
6. The art of Project management, Scott Berkun, O'Reilly.
6. Any other book(s) covering the contents of the paper in more depth..

Note: Latest and additional good books may be suggested and added from time to time

Elective-II Paper:
EL-2.4 INFORMATION SECURITY
(23CSAPH11C4)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Information Security	**Course Code**	23CSAPH11C4
Hours/Week	2	**Credits**	2
Max. Marks.	50	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one Compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 7 = 35 marks)

Course Objectives:

1. Know about information security
2. Learn security attacks
3. Know about Conventional Encryption Principles & Algorithms
4. Learn the concept of email security
5. Know about web security and the irimplementation

Course Outcomes:

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

1. Identify some of the factors driving the need for network security
2. Identify and classify particular examples of attacks
3. Define the vtermsvulnerability, threat and attack
4. Identify physical points of vulnerability in simple networks
5. Compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems.

Unit– I

Security Goals, Security Attacks Interruption, Interception, Modification and Fabrication Security Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internet work security, Internet Standards and RFCs

Unit–II

Conventional Encryption Principles & Algorithms(DES, AES, RC4), Block Cipher Modes of Operation, Location of Encryption Devices, Key Distribution, Public key cryptography principles, public key cryptography algorithms(RSA, RABIN, ELGAMAL, Diffie-Hellman, ECC), Key Distribution.

Unit– III

Approaches of Message Authentication, Secure Hash Functions (SHA-512, WHIRLPOOL) and HMAC.

Digital Signatures: Comparison, Process- Need for Keys, Signing the Digest, Services, Attacks on Digital Signatures, Kerberos, X.509 Directory Authentication Service.

Unit– IV

Email Security: Pretty Good Privacy (PGP) and S/MIME. IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management.

Web Security Requirements, Secure Socket Layer(SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET).Basic concepts of SNMP, SNMPv1 Community facility and SNMPv3, Intruders, Viruses and related threats, Virus Countermeasures Firewall Design principles, Trusted Systems, Intrusion Detection Systems.

Suggested Readings:

1. Network Security Essentials (Applications and Standards) by William Stallings, Pearson Education.
2. Cryptography & Network Security by Behrouz A.Forouzan,TMH.
3. Information Security by Mark Stamp, Wiley–India.
4. Information Systems Security, Godbole, Wiley Student Edition.
5. Cryptography and Network Security by William Stallings, Pearson Education.
6. Any other book(s) covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time

Elective-II Paper:
EL-2.5 MACHINE LEARNING AND PYTHON PROGRAMMING
(23CSAPH11C4)

Name of the Program	Ph.D. Course Work in Computer Science	**Program Code**	CSAPH
Name of the Course	Machine Learning and Python Programming	**Course Code**	23CSAPH11C4
Hours/Week	2	**Credits**	2
Max. Marks.	50	**Time**	3Hours

Note: The examiner has to set a total of nine questions (two from each unit and one Compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 7 = 35 marks)

Course Objectives:

1. Understand Fundamental Machine Learning Concepts.
2. Develop Proficiency in Python Programming.
3. Implement and Evaluate Machine Learning Models.
4. Apply Machine Learning Techniques to Real-World Problems.
5. Gain Practical Experience through Hands-On Projects.

Course Outcomes:

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

1. Identify some of the factors driving the need for network security
2. Identify and class Ifyparticular examples of attacks
3. Define the terms vulnerability, threat and attack
4. Identify physical points of vulnerability in simple networks
5. Compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems.

Unit– I

MachineLearningConcepts: IntroductiontoMachineLearning,MachineLearningapplications, Typesof learning: Supervised, Unsupervised and semi-supervised, reinforcement learning techniques, Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models, Predictive and descriptive learning, Classification concepts, Binary and multi-class classification.

LearningTheory: FeatureExtraction,FeatureConstructionandTransformation,FeatureSelecti on,Dimensionality Reduction: Subset selection, the Curse of dimensionality, Principle Components analysis, Independent Component analysis, Factor analysis, Multidimensional scaling, Linear discriminant analysis, Bias/Variance tradeoff, Union and Chhernoff/ Hoeffding bounds, VC dimension, Probably Approximately Correct (PAC) learning, Concept learning, the hypothesis space, Least general generalization, Inter naldisjunction, Paths through the hypothes is space, model Evaluationand selection.

Unit–II

Geometric Models: Regression, Logistic regression , Assessing performance of regression - Error measures, Overfitting, Least square method, Multivariate Linear regression, Regression for Classification, Perceptron, Multi-layer perceptron, Simple neural network, Kernel based methods, Support vector machines(SVM), Soft margin SVM, Support Vector Machines as a linear and non-linear classifier, Limitations of SVM, Concept of Relevance Vector, K-nearest neighbor algorithm

Logical, Grouping And Grading Models: Decision Tree Representation, Alternative measures for selecting attributes, Decision tree algorithm: ID3, Minimum Description length decision trees, Ranking and probability estimation trees, Regression trees, Clustering trees, Rule learning for subgroup discovery, Association rule mining, Distance based clustering-K-means algorithm, Choosing number of clusters, Clustering around medoids – silhouettes, Hierarchical clustering, Ensemble methods: Bagging and Boosting.

Unit– III

Probabilistic Models: Uncertainty, Normal distribution and its geometric interpretations, Baye's theorem, Naïve Bayes Classifier, Bayesian network, Discriminative learning with maximum likelihood, Probabilistic models with hidden variables, Hidden Markov model, Expectation Maximization methods, Gaussian Mixtures and compression based models.

Case Studies on Advanced Machine Learning Techniques: Diagnosis of human disease, Diagnosis of crop disease, Text mining tasks like semantic analysis, author profiling, author identification, language identification, summarization etc., Prediction & forecasting, Fraud detection, Learning to rate vulnerabilities and predictexploits.

Unit– IV

Programming with Python: Introduction to Python and Computer Programming; Data Types, Variables, Basic Input-Output Operations, Basic Operators; Boolean Values, Conditional Execution, Loops, Lists andList Processing, Logical and Bitwise Operations; Functions, Tuples, Dictionaries, and Data Processing; Modules, Packages, String and List Methods, and Exceptions; The Object-Oriented Approach: Classes, Methods, Objects, and the Standard Objective Features; Exception Handling, and Working with Files.

Suggested Readings:

1. C.M. Bishop: Pattern Recognition and Machine learning, Springer.
2. Hastie, Tibshirani, Friedman: Introduction to statistical machine learning with applications in R,Springer.
3. Tom Mitchell: Machine Learning, McGrawHill.
4. Parag Kulkarni: Reinforcement and Systemic Machine learning for Decision Making, Wiley-IEEE Press.
5. Any other book(s) covering the contents of the paper in more depth.

Note: Latest and additional good books may be suggested and added from time to time.