MAHARSHI DAYANAND UNIVERSITY, ROHTAK
SCHEME AND SYLLABUS FOR Ph.D COURSE WORK COMPUTER SCIENCE

DOCTOR OF PHILOSOPHY (Ph.D) COMPUTER SCIENCE COURSE WORK
(w.e.f. the session 2020-21)

Programme 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 findings in the individual research area.
PSO5 Understand the most advanced research in the candidate's specialization area of Computer Science respectively

Scheme of Examination
w.e.f. 2020-21

Duration : One Semester (Six months)

Total Credits: 14 credits

Semester-1							
S.No.	Course Code	Course Title	External Marks	Internal Marks	Total Marks	Hours per Week	**Credits**
1.	20CSAPC1 (Compulsory)	Research Methodology & Its Relevance in Computer Science	80	20	100	4 Hours	4
2	20MPCC1 (Compulsory)	Research and Publication Ethics	40	10	50	2 Hours	2
3.	20CSAPC3	Elective-1	80	20	100	4 Hours	4
4.	20CSAPC4	Elective-2	80	20	100	4 Hours	4
	Total Marks				350		14

Note: i. The compulsory course on 'Research and Publication Ethics' shall be offered by Ch. Ranbir Singh Institute of Social and Economic Change.

List of Electives Papers

Students can choose any two elective papers from the following list of papers:

1.	Data Warehousing And Mining
2.	Mobile Computing
3.	BIG Data Analytics
4.	Web Analytics & Intelligence
5.	Software Testing And Quality Assurance
6.	Adhoc and Sensor Networks
7.	Software Design And Engineering
8.	Information Security

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

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	Research Methodology & Its Relevance In Computer Science	**Course Code**	20CSAPH11C1
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 marks)

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:

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. To understand sources of data collection and how data is collected from different sources.
5. To 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

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, response surface 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.

References:

1. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments
2. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India)
3 Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi)
4. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006), Management Resarach Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
5. The complete reference Office Xp – Stephan L. Nelson, Gujulia Kelly (TMH)

Subject: Research and Its Publication Ethics

20CSAPH11C2

(Compulsory)

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

Elective-I Paper:
EL-1.1 DATA WAREHOUSING AND MINING

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	Data Warehousing and Mining	**Course Code**	20CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 marks)

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 query languages.
5. Know in detail about data mining algorithms

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Course Outcomes:

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 Association Mining to Correlation Analysis, Constraint-Based Association Mining. **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

Cluster Analysis Introduction: Types of Data in Cluster Analysis, A Categorization of Major 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.

References:

1. Data Mining – Concepts and Techniques - Jiawei Han & Micheline Kamber, Morgan Kaufmann Publishers, 2nd Edition, 2006.
2. Introduction to Data Mining – Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Pearson education.
3. Data Warehousing in the Real World – Sam Aanhory & Dennis Murray Pearson Edn Asia.
4. Data Warehousing Fundamentals – Paulraj Ponnaiah Wiley student Edition
5. The Data Warehouse Life cycle Tool kit – Ralph Kimball Wiley student edition

Elective-1 Paper:
EL-1.2 MOBILE COMPUTING

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	Mobile Computing	**Course Code**	20CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 marks)

Course Objectives:

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

Course Outcomes:

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**:** Infrared vs. radio transmission, Infrastructure and ad hoc 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

Mobile Transport Layer: Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, 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.

References:

1. Jochen Schiller, “Mobile Communications”, *Pearson Education*., second edition, 2004
2. Raj kamal, Mobile Computing, OXFORD Universit y Press
3. Asoke Talukder, Roopa Yavagal “Mobile Computing, Tata McGraw Hill
4. Reza Behravanfar, “Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML”, Cambridge University Press, October 2004.
5. C.Siva Ram murthy, B.S. Manoj, Adhoc wireless networks, architectures and protocols peason education

Elective-1 Paper:
EL-1.3 BIG DATA ANALYTICS

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	**BIG DATA ANALYTICS**	**Course Code**	20CSAPH11C2
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 marks)

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:

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 R software.
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 databases, 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.

References:

1. Minelli M., Chambers M., Dhiraj A., Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business Wiley, 2013
2. Viktor Mayer-Schonberger, Kenneth Cukier, Big Data: A Revolution that will transform how we live, work and think.
3. Big Data Black Book by DT Editorial Services, dreamtech publications 2015.
4. Seema Acharya & Subhashini Chellappan, Big data and Analytics, Wiley publishers
5. A.K. Pujari: Data Mining Techniques, University Press.

Elective-1 Paper:
EL-1.4 INFORMATION RETRIEVAL SYSTEMS

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	Information Retrieval Systems	**Course Code**	20CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 hours

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 16 = 80 marks)

Course Objectives:

1. Learn the basic concept of information retrieval system
2. Know the concept of Cataloging and Indexing
3. Learn about Document and Term Clustering
4. Know about Text Search Algorithms
5. Learn about Multimedia Information Retrieval

Course Outcomes:

1 To identify Data Base Management systems and data ware houses
2 To use knowledge of data structures and indexing methods in information retrieval Systems
3 To choose clustering techniques for different data base systems
4 To choose searching techniques for different data base systems
5 To Explain different types of search algorithms like Hardware text search systems and software text search systems

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Unit – I

Introduction: Definition, Objectives, Functional Overview, Relationship to DBMS, Digital libraries and Data Warehouses, Information Retrieval System Capabilities - Search, Browse, Miscellaneous.

Unit – II

Cataloging and Indexing: Objectives, Indexing Process, Automatic Indexing, Information Extraction, Data Structures: Introduction, Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure, Signature file structure, Hypertext data structure - Automatic Indexing: Classes of automatic indexing, Statistical indexing, Natural language, Concept indexing, Hypertext linkages

Unit – III

Document and Term Clustering: Introduction, Thesaurus generation, Item clustering, Hierarchy of clusters - User Search Techniques: Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, Weighted searches of Boolean systems, Searching the Internet and hypertext - Information Visualization: Introduction, Cognition and perception, Information visualization technologies.

Unit – IV

Text Search Algorithms: Introduction, Software text search algorithms, Hardware text search systems; Information System Evaluation: Introduction, Measures used in system evaluation, Measurement example – TREC results. **Multimedia Information Retrieval:** Models and Languages: Data Modeling, Query Languages, Indexing and Searching Libraries and Bibliographical Systems – Online IR Systems, OPACs, Digital Libraries.

References:

1. Information Storage and Retrieval Systems: Theory and Implementation by Kowalski, Gerald, Mark T Maybury Kluwer Academic Press, 2000.
2. Modern Information Retrival By Ricardo Baeza-Yates, Pearson Education, 2007.
3. Information Retrieval: Algorithms and Heuristics By David A Grossman and Ophir Frieder, 2nd Edition, Springer International Edition, 2004
4. Information Retrieval Data Structures and Algorithms By William B Frakes, Ricardo Baeza-Yates, Pearson Education, 1992.
5. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, Cambridge University Press, 2008

Elective-1 Paper:
EL-1.5 PATTERN RECOGNITION

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	EL-1.5 Pattern Recognition	**Course Code**	20CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 hours

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 16 = 80 marks)

Course Objectives:

1. Know the basic concept of pattern recognition.
2. Learn the concept of probability.
3. Learn about estimation of parameters from sample
4. Know about statistical decision making.
5. Learn about Non Parametric Decision Making

Course Outcomes:

1 Identify areas where Pattern Recognition and Machine Learning can offer a solution
2 Describe genetic algorithms, validation methods and sampling techniques
3 Describe some discriminative, generative and kernel based techniques
4 Describe and model sequential data. Implement learning algorithms for supervised tasks.
5 Present a literature review on a topic related to Machine Learning and Pattern Recognition

Unit – I

Introduction: Pattern Recognition Systems, Design Cycle, Applications of pattern recognition, Learning and Adaption-Supervised, Unsupervised and Reinforcement Learning: Tree Classifiers Getting our feet wet with real classifiers: Decision Trees: CART, C4.5, ID3.Random Forests Bayesian Decision. Parametric Techniques. Non-Parametric Techniques. Component Analysis and Dimension Reduction. The Curse of Dimensionality and Principal Component Analysis.

Unit – II

Probability: Introduction to Probability, Probability of events, Random variables, Probability Distributions, Joint Distribution and Densities, Moments of Random Variables, Estimation of Parameters from samples, Minimum Risk Estimators.

Unit – III

Statistical Decision Making: Bayes' Decision Theory, Multiple Features, Conditionally Independent Features, Decision Boundaries, Unequal costs of Error, Estimation of Error Rates, Leaving-one-out Technique, Confusion Matrix, Characteristic Curves. Classifiers: Hidden Markov Model, Support Vector Machine, Artificial Neural network-back Propagation Algorithm and Fuzzy based classifiers.

Unit – IV
Non Parametric Decision Making: Introduction, Histograms, Kernel and window Estimators, Nearest Neighbor classification Technique, Adaptive Decision Boundaries, Adaptive Discriminate Functions, Minimum Squared Error Discriminate Functions. Clustering: Introduction, Hierarchical clustering, Partitioning Clustering.
References: 1. Pattern Recognition and Image Analysis, Earl Gose, Richard Johnsonbaugh and Steve Jost, PHI, 1996. 2. Pattern Classification, Richard O Duda, Peter E. Hart and David G. Stork, John Wiley, 2000. 3. Patter Recognition by sergios Koutroumbas, Elsvier. 4 Patter Recognition and classification.: an Introduction by Dougherty 5. Patter Recognition and machine Learning by CM Bishop

Elective-1 Paper:
EL-1.6 WEB ANALYTICS AND INTELLIGENCE

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	EL-1.6 WEB ANALYTICS AND INTELLIGENCE	**Course Code**	20CSAPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 marks)

Course Objectives:

1. Learn the concept of Web Analytics and Intelligence
2. Know about web log, 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:

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, JavaScript tags, 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 adwords 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

Web Analytics 2.0:Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 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.

References:

1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed.
2. Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed.
3. Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons
4. Web Analytics 2.0 by Avinash Kaushik.
5. Web Analytics an hour a Day by Avinash Kaushik.

Elective-II Paper:
EL-2.1 SOFTWARE TESTING AND QUALITY ASSURANCE

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	EL.2.1 Software Testing and Quality Assurance	**Course Code**	20CSAPH11C4
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 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:

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.

References:

1. A Practitioner's Guide to Test Case Design by LEE Copland, Artech House Publishers, Boston - London.
2. Software Testing – A Craft's man Approach, Paul C. Jorgensen, A CRC Press LLC.
3. Software Quality Theory and Management by Alan C. Gillies, Chapman & Hall.
4. Software Quality by Galrry S. Marliss , Thomson.
5. Metrics and Models in Software Quality Engineering by Stephen H. Kan , Pearson Education.

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

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	EL-2.2 Adhoc and Sensor Networks	**Course Code**	20CSAPH11C4
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 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 Retrieval in Sensor Networks

Course Outcomes:

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 characteristics 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 Geocasting. TCP over Ad Hoc: TCP protocol overview, TCP and MANETs, Solutions for TCP over 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, Berkeley motes, Sensor Network Programming Challenges, Node-Level Software Platforms - Operating System: TinyOS – Imperative Language**:** nesC, Dataflow style language: TinyGALS, Node-Level Simulators, ns-2 and its sensor network extension, TOSSIM.

References:

1. Ad Hoc and Sensor Networks – Theory and Applications, *Carlos Corderio Dharma P.Aggarwal,* World Scientific Publications, March 2006, ISBN – 981-256-681-3
2. Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, Leonidas Guibas, Elsevier Science, ISBN – 978-1-55860-914-3 (Morgan Kauffman
3. Ad hoc and sensor network: Theory and applications by DP Aggarwal
4. Wireless Ad hoc and sensor network: Protocol, performance and control by Jagannathan Sarangapani
5 Wireless Ah hoc and senseor Network by Welly

Elective-II Paper:
EL-2.3 EMBEDDED SYSTEMS

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	EL-2.3 Embedded Systems	**Course Code**	20CSAPH11C4
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 marks)

Course Objectives:

1. Know about Embedded Systems
2. Understand the concept of 8051 and Advanced Processor Architecture
3. Learn about Devices and Communication Buses for Devices Network
4. Learn about Real – Time Operating Systems
5. Know the concept of Embedded Software Development Process and Tools

Course Outcomes:

1 To acquire knowledge about microcontrollers embedded processors and their applications.
2 Interfacing of different peripheral devices with Microcontrollers.
3 To write the programs for microcontroller.
4 To understand the role of embedded systems in industry.
5 To understand the design concept of embedded systems.

Unit – I

Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software, Complex System Design, and Design Process in Embedded System, Formalization of System Design, and Classification of Embedded Systems

Unit – II

8051 and Advanced Processor Architecture: 8051 Architecture, 8051 Micro controller Hardware, Input /Output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/ Output, Interrupts, Introduction to Advanced Architectures, Real World Interfacing, Processor and Memory organization.

Devices and Communication Buses for Devices Network: Serial and parallel Devices & ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Internet Enabled Systems, Wireless and Mobile System protocols

Unit – III

Embedded Programming Concepts: Software programming in Assembly language and High Level Language, Data types, Structures, Modifiers, Loops and Pointers, Macros and Functions, object oriented Programming, Embedded Programming in C++ & JAVA.

Unit – IV

Real – Time Operating Systems: OS Services, Process and Memory Management, Real – Time Operating Systems, Basic Design Using an RTOS, Task Scheduling Models, Interrupt Latency, Response of Task as Performance Metrics. RTOS Programming: Basic functions and

Types of RTOSES, Windows CE.

Embedded Software Development Process and Tools: Introduction to Embedded Software Development Process and Tools, Host and Target Machines, Linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware-Software Design and Co-Design Testing, Simulation and Debugging Techniques and Tools: Testing on Host Machine, Simulators, Laboratory Tools

References:

1. Embedded Systems, Raj Kamal, Second Edition TMH.
2. Embedded/Real-Time Systems, Dr.K.V.K.K.Prasad, dreamTech press
3. The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Pearson.
4. The 8051 Microcontroller, Third Edition, Kenneth J.Ayala, Thomson.
5. An Embedded Software Primer, David E. Simon, Pearson Education.

Elective-II Paper:
EL-2.4 DIGITAL IMAGE PROCESSING

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	EL-2.4 Digital Image Processing	**Course Code**	20CSAPH11C4
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 marks)

Course Objectives:

1. Know about digital image processing
2. Learn on Statistical and spatial operations
3. Understand about basic morphological operations
4. Learn about Segmentation and Edge detection region operations
5. Know about Image Transforms

Course Outcomes:

1 Quantize and to perform sampling on given images.
2 Transform and filter the digital image for improving the image quality.
3 Generate Color images by applying different image characteristics.
4 Compress the digital images by applying different lossless and lossy compression techniques.
5 Identify different representations of digital images.

Unit – I

Fundamental steps of image processing, components of an image processing of system, the image model and image acquisition, sampling and quantization, station ship between pixels, distance functions, scanner.

Unit – II

Statistical and spatial operations, Grey level transformations, histogram equalization, smoothing & sharpening-spatial filters, frequency domain filters, homomorphic filtering, image filtering & restoration. Inverse and weiner filtering FIR weiner filter. Filtering using image transforms, smoothing splines and interpolation.

Unit – III

Morphological and other area operations, basic morphological operations, opening and closing operations, dilation erosion, Hit or Miss transform, morphological algorithms, extension to grey scale images.

Segmentation and Edge detection region operations, basic edge detection, second order detection, crack edge detection, gradient operators, compass and laplace operators, edge linking and boundary detection, thresholding, region based segmentation, segmentation by morphological watersheds.

Unit – IV

Types and requirements, statistical compression, spatial compression, contour coding, quantizing compression, image data compression-predictive technique, pixel coding, transfer coding theory, lossy and lossless predictive type coding. Basics of color image processing, pseudocolor image processing, color transformation, color smoothing and sharpening, color segmentation, color image compression, compression standards.

Image Transforms - Fourier, DFT, DCT, DST, Haar, Hotelling, Karhunen -Loeve, Walsh, Hadamard, Slant. Representation and Description, Chain codes, Polygonal approximation, Signatures Boundary Segments, Skeltons, Boundary Descriptors, Regional Descriptors, Relational Descriptors, PCA.

References:

1. Digital Image Processing – by Rafael.C.Gonzalez & Richard E.Woods, 3rd edition, Pearson Education, 2008.
3. Fundamentals of Digital Image Processing – by A.K. Jain, PHI
4. Digital Image Processing – William K, Part I - John Wiley edition.
5. Digital Image Processing using MATLAB – by Rafael.C.Gonzalez, Richard E.Woods, & Steven

Elective-II Paper:
EL-2.5 SOFTWARE DESIGN AND ENGINEERING

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	EL-2.5 Software Design and Engineering	**Course Code**	20CSAPH11C4
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 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:

1 Appreciate the engineering nature of software development
2 Describe key activities in software development and the role of modelling
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 workflow 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 attributes of the design product, assessing the design process.

Transferring Design Knowledge-Representing abstract ideas; design viewpoints, the architecture 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 decomposition, design by composition and organizational influences 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.

References:

1. Software design, David Budgen, second edition, Pearson education, 2003.
2. Software Engineering: A practitioner's Approach, Roger S Pressman, seventh edition Mc-Graw Hill International Edition, 2009.
3. Software Engineering, Ian Sommerville, seventh edition, Pearson education,2004.
4. Software Project Management, Bob Hughes & Mike Cotterell, fourth edition,Tata Mc-Graw Hill,2006
5. The art of Project management, Scott Berkun, O'Reilly, 2005.

Elective-II Paper:
EL-2.6 INFORMATION SECURITY

Name of the Program	Ph.D. Course work in Computer Science & Applications	**Program Code**	CSAPH
Name of the Course	Research and Publication Ethics	**Course Code**	20CSAPH11C4
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

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 16 = 80 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 their implementation

Course Outcomes:

1 Identify some of the factors driving the need for network security
2 Identify and classify particular 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

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

References:

1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education, 2008
2. Cryptography & Network Security by Behrouz A. Forouzan, TMH 2007.
3. Information Security by Mark Stamp, Wiley – India, 2006.
4. Information Systems Security,Godbole,Wiley Student Edition.
5. Cryptography and Network Security by William Stallings, Fourth Edition,Pearson Education 2007.