University Institute of Technology (UIT)

Silver Wood Estate, H. P. University, Shimla-171005

(NAAC Accredited "A-Grade" University)

DEPARTMENT
of
COMPUTER SCIENCE ENGINEERING

Course Work Syllabus

for

Doctor of Philosophy
in
Computer Science Engineering

Effective from the Session 2021-2022

COURSE OF STUDY FOR DOCTORAL PROGRAMME

Semester-wise course of study for Doctoral Programme

The following distribution of credits along with time-line for different courses of study shall be followed as given in the following table.

SCHEME AND SYLLABI FOR PH.D DEGREE PROGRAMME (Computer Science Engineering)

Semester 1 (Coursework)

Subject Code	Subject	Schedule of Teaching			Schedule of Examination	
		L	P	Credits	TA	ESE
HSMC-101	Research Methodology	4	0	4	50	100
	Elective 1	4	0	4	50	100
	Elective 2	4	0	4	50	100
	Total	**12**		**12**	**450**	

Semester II

Subject	Schedule of Teaching		
	L	**P**	**Credits**
Research proposal writing and presentation	-	-	4
Review article writing	-	-	4
Total	**-**	**-**	**8**

S.No.	Subject code	Elective Subjects
1	PHES101	Advanced Computer Architecture
2	PHES102	Theory of Programming Languages
3	PHES103	Network security and Cryptography
4	PHES104	Software Quality and Testing
5	PHES105	Mobile and Wireless computing
6	PHES106	Software Engineering
7	PHES107	Cloud Computing
8	PHES108	Data Analytics
9	PHES109	Cyber Forensics
10	PHES110	Wireless Sensor Network

L – Lecture,

P – Practical

TA - Teacher's Assessment (Assignments, attendance, group discussion, Quiz, tutorials, seminars, etc.)

ESE - End Semester Examination to be conducted by the University

Name of the Course	**Research Methodology**		
Course Code	**HSMC-101**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To formulate a viable research question.
- To distinguish probabilistic from deterministic explanations.
- To analyse the benefits and drawbacks of different methodologies.
- To understand how to prepare and execute a feasible research project.

Section	Course Content
Section-A	Research Aptitude: Meaning of Research, Objectives of Research, and Motivation in Research, Types of Research, Research Approaches, and Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done. Research Process: Reviewing the literature, Formulation of research problem, Nature and type of variables, Hypothesis - meaning, types, development of hypothesis and its testing, Meaning & Functions of Research Design.
Section-B	Data Analysis: Sources, acquisition and interpretation of data, Quantitative and qualitative data, Graphical representation and mapping of data, Sensitivity Analysis with Data Tables, Optimization with EXCEL Solver, Summarizing Data with Histograms and Descriptive Statistics, Pivot Tables, Summarizing Data with database statistical functions, using correlation, Multiple Regression, Using Sampling to Analyse Data.
Section-C	Significance of Report Writing : Different Steps in writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Art of

	scientific writing- Steps to better writing, flow method, organization of material and style, Drawing figures, graphs, tables, footnotes, references etc. in a research paper.
Section-D	Use of Internet in Research Work : Use of internet networks in research activities in searching material, paper downloading, submission of papers, relevant websites for journals and related research work. Introduction to Patent laws etc., process of patenting a research finding, Copy right, Cyber laws.

Course Outcomes:

CO1: Identify the complex issues inherent in selecting a research problem,
CO2: Select an appropriate research design, and implementing a research project.
CO3: Explain key research concepts and issues
CO4: Read, comprehend, and explain research articles in their academic discipline.

Text Book:

1. Kothari, C. R., "Research Methodology Methods and Techniques", Wiley Eastern Ltd.

Reference Books:

1. Wayne L. Winston, "Microsoft Excel Data Analysis and Business Modelling", Microsoft Press.
2. Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", Pearson Education.
3. Dawson, C., "Practical Research Methods", UBSPD Pvt. Ltd.
4. Sharma, N. K., "Research Methodology", KSK Publishers.

Name of the Course	**Advanced Computer Architecture**		
Course Code	**PHES-101**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To offers a good understanding of the various functional units of a computer system.
- To prepare the student to be in a position to design a basic computer system.

Section	**Course Content**
Section-A	Parallel Computer Models: The State of Computing, Multiprocessors and Multi computers, Multi-vector and SIMD Computers, Random Access Machines, VLSI Complexity Model Program and Networks Properties: Conditions of Parallelism, Program Partitioning and Scheduling, Program Flow Mechanisms, System Interconnect Architectures
Section-B	Principles of Scalable Performance: Performance Metrics and Measures, Speedup, Performance Laws, Scalability Analysis and Approaches Processors and Memory Hierarchy: Advance Processor Technology, Superscalar and Vector Processors, memory hierarchy technology, virtual memory technology.
Section-C	Multiprocessors and Multicomputers: Multiprocessor System Interconnects, Cache Coherence and Synchronization Multivector and SIMD Computers**:** Vector Processing Principles, Multivector multiprocessors, compound vector processing, SIMD computer organizations, the connection machines.

Section-D	Parallel Models, languages and compilers: parallel programming models, parallel languages and compilers, dependence analysis of data arrays, code optimization and scheduling. Parallel program development and environment: parallel programming environments, synchronization and multiprocessing modes, shared variable program structures, message passing program development.

Course Outcomes:

CO1: Demonstrate concepts of parallelism in hardware/software.
CO2: Describe architectural features of advanced processors.
CO3: Interpret performance of Parallel Computer.
CO4: Learn how program can be decomposed for parallel execution

Text Books:

1. Kai Hwang: Advanced Computer Architecture: Parallelism, Scalability, Programmability, Tata McGraw-Hill.

Reference Books:

1. Parallel Computing – Theory and Practice by Michael J. Quinn, 2nd Edition, McGraw Hill.
2. Design and Analysis of Parallel Algorithms by S.G. Akl, Prentice Hall.
3. Analysis and Design of Parallel Algorithms - Arithmetic and Matrix Problems, by S. Lakshmivarahan and S.K. Dhall, McGraw Hill International Edition.
4. A Practical Approach to Parallel Computing by S.K. Ghosal , Universities Press Limited
5. Computer Architecture and parallel processing by Hwang Briggs, McGraw Hill, 1984.
6. Advanced Computer Architectures: A design space approach by Dezsosima, Terence Fountain, Peter Karsuk, Addison Wesley, 1997.

Name of the Course	**Theory of Programming Languages**		
Course Code	**PHES-102**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To understand the fundamental limits on what can be efficiently computed in our universe and other possible universes.
- To reveal deep and mysterious properties about information, knowledge, and processing, as well as practical issues about what can and cannot be computed.

Section	**Course Content**
Section-A	Introduction: Automata, Computability, and Complexity, Mathematical Notions and Terminology, Definitions, Theorems, and Proofs, Types of Proof Regular Languages: Finite Automata, Non determinism, Regular Expressions, Non regular Languages, Context-Free Languages: Context-free Grammars, Pushdown Automata, Non-context-free Languages.
Section-B	The Church-Turing Thesis: Turing Machines, Variants of Turing Machines, The Definition of Algorithm Decidability: Decidable Languages, the Halting Problem Reducibility: Undecidable Problems from Language Theory, a Simple Undecidable Problem, Mapping Reducibility
Section-C	Advanced Topics in Computability Theory: The Recursion Theorem, Decidability of logical theories, Turing Reducibility Time Complexity: Time Complexity, The Class P, The Class NP, NP-completeness, additional NP-complete Problems.
Section-D	Space Complexity and Intractability: Savitch's Theorem, Hierarchy Theorems, Relativization, Circuit Complexity, Advanced topics in Complexity Theory: Approximation Algorithms, probabilistic algorithms, Alternation, Interactive

	Proof Systems, Parallel Computation, cryptography.

Course Outcomes:

CO1: Reveal deep and mysterious properties about information, knowledge, and processing, as well as practical issues about what can and cannot be computed.

CO2: Understand a wide range of programming language constructs and features.

CO3: Understand language paradigm, and elements of programming languages.

CO4: Apply programming languages knowledge and design algorithms that solve small-to-moderate scale computational problems.

Text Books:

1. Michael Sisper, Introduction to the Theory of Computation, 2nd edition, International Thompson Publishing, 2006.

Reference Books:

1. Introduction to Languages and Theory of Computation, Third edition, John C. Martin – McGraw Hill.
2. Introduction to Automata Theory, Languages and Computation by J. E. Hopcroft and J. D. Ullman pub. PEARSON Education.
3. Theory of Recursive Functions and Effective Computability by Hartley Rogers, MIT Press.
4. Introduction to Computability by Fred C. Hennie. S.K. Dhall, McGraw Hill International Edition.

Name of the Course	**Network Security & Cryptography**		
Course Code	**PHES-103**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To know the methods of conventional encryption
- To understand the concepts of public key encryption and number theory
- To understand authentication and Hash functions
- To know the network security tools and applications.
- To understand the system level security used.

Section	**Course Content**
Section-A	OSI Security Architecture, Classical Encryption techniques, Cipher Principles, Data Encryption Standard, Block Cipher Design Principles and Modes of Operation, Evaluation criteria for AES, AES Cipher, Triple DES, Placement of Encryption Function, Traffic Confidentiality Security trends, Attacks and services, classical cryptosystems, Different types of ciphers, LFSR sequences, Basic number theory, Congruence's, Chinese remainder theorem, Modular exponentiation, Fermat and Euler's theorem, Finite fields, continued fractions
Section-B	Simple DES, Differential Crypto analysis, DES, Modes of operation, Triple DES, AES, RC4, RSA, Attacks, Primality test factoring, Authentication requirements, Authentication functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs, MD5 message Digest algorithm, Secure Hash Algorithm, RIPEMD, HMAC Digital Signatures, Authentication Protocols, Digital Signature Standard.
Section-C	Authentication applications, Kerberos, X.509, PKI, Electronic Mail Security, PGP, S/MIME, IP Security, Web Security, SSL,TLS, SET.

	Browser general concepts, functionalities, browsers war, browsers comparison, browser security (add-ons, same-origin policy etc.) and secure browsing.
Section-D	System Security, intrusion detection, Password Management, Malicious Software, Viruses and related threats, Virus Countermeasures, Distributed denial of service attacks. Firewalls- Firewalls design principles, Trusted systems, Common criteria for Information Technology Security Evaluation.

Course Outcomes:

CO1: Develop Concept of Security needed in Communication of data through computers and networks along with Various Possible Attacks

CO2: Understand Various Encryption mechanisms for secure transmission of data and management of key required for required for encryption.

CO3: Understand authentication requirements and study various authentication mechanisms.

CO4: Understand network security concepts and study different Web security mechanisms

Text Books:

1. William Stallings, "Cryptography & Network Security - Principles and Practices", Prentice Hall of India, Third Edition, 2003.
2. Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", 2nd edition, Pearson, 2007.

Reference Books:

1. W. Mao, "Modern Cryptography –Theory and Practice", Pearson Education, Second Edition 2007.
2. Charles P. Pfleeger, Shri Lawrence Pfleeger-Security in Computing 3rd edition-Prentice Hall of India.

Name of the Course	**Software Quality and Testing**		
Course Code	**PHES-104**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- The Objective of this course is to introduce students to the fundamental of Software Testing and Quality Assurance.

Section	Course Content
Section-A	Introduction: Testing and Debugging, Bugs, Faults and failures, Common causes of Defects. Software Testing: Background, Purpose and Fundamentals, Characteristics. Software Development Life Cycle and Testing: Life Cycle Models: Waterfall Model, the V Model, Prototyping Model, W Model, Software Development Process Testing: Compatibility Testing, Usability Testing, Website Testing, Testing for Software Security, Unit Testing, Integration Testing, Alpha Testing Beta Testing, Building a Software Testing Process.
Section-B	Testing Fundamentals: Static Testing, Dynamic Testing, Examining the Specification Black Box and White Box testing, Static and Dynamic Testing, Static Black Box Testing Testing the Software Dynamic Black Box Testing, Test –to-pass and Test –to-fail, Data Testing, State Testing, Syntax Testing Examining the Code Static White-box Testing, Generic Code Review Checklist, Automated Testing and Test Tools Test Tools**,** Software Test Automation**,** Random Testing.
Section-C	Writing and Tracking Test case Planning Test Design, Test Case, Test Procedures, Test Case Organization Software Reviews Cost Impact of software Defects, Defect Amplification and Removal Formal technical Reviews The

	Review Meeting, Review Reporting and Record Keeping, Review Guidelines, Sample Driven Reviews.
Section-D	Quality Management Quality Concept, Quality assurance, Cost of Quality, Software Quality Assurance Capability Maturity Model (CMM),Background issues, SQA Activities, Statistical Software Quality Assurance, A Generic Example, Six Sigma for Software Engineering.

Course Outcomes:

CO1: Write test plans, test cases and report defects for standalone, client-server and web based applications.

CO2: List a range of different software testing techniques and strategies and be able to apply specific (automated) unit testing method to the projects.

CO3: Demonstrate the integration testing which aims to uncover interaction and compatibility problems as early as possible.

CO4: Learn SQA activities and software quality standards.

Text Books:

1. Software Testing' by Ron Patton, Second Edition, Sams Publications.
2. 'Software Engineering' by Roger S. Pressman, 7th Edition, McGraw Hill Publications.

Reference Books:

1. 'Effective methods for Software Testing' by Willam E. Perry, 3rd Edition, Wiley Publishers.
2. 'Practical Software Testing' by Ilene Burnstein, 2nd Edition, Springer-Verlag Publishers.
3. 'Software Engineering and Testing' by B. B. Agarwal,S. P. Tayal, M. Gupta, Laxmi Publications.

Name of the Course	**Mobile and Wireless Networks**		
Course Code	**PHES-105**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:

The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To study the standards of Wireless LAN , Sensor and ADHOC networks
- To learn about Mobile nodes and IP
- To study the latest protocols and applications of wireless and Mobile standards

Section	Course Content
Section-A	INTRODUCTION TO WIRELESS Introduction to wireless transmission- signal propagation- Multiplexing-Modulation-Spread Spectrum-Fading-Coding and Error control. WIRELESS LANS Wireless LAN Technology-IEEE 802.11, IEEE 802.16, HIPERLAN, WiMax, Bluetooth, Role of Wireless Local loops.
Section-B	WIRELESS ATM WATM Services, Reference Model, Handover, Location Management, Mobile QOS, Access Point Control Protocol. INTRODUCTION Introduction to Mobile Computing, GSM, 1G, 2G, 3G and 4G.
Section-C	WIRELESS MAC Medium access Control Techniques- SDMA, TDMA, FDMA, CDMA Comparison. Tele-communication systems- GSM-DECT and TETRA. MOBILE NETWORK LAYER

	Mobile IP, DHCP, Mobile Transport Layer.
Section-D	MANET Overview, Properties of MANET, spectrum of MANET applications, routing and various routing algorithms, security in MANETs. PROTOCOLS AND TOOLS Wireless Application Protocol- WAP, Introduction, Protocol architecture and treatment of protocols of all layers.

Course Outcomes:

CO1: Be familiar with various wireless concepts/technologies.
CO2: Learn mobile computing and standards.
CO3: Understand GSM and MANET.
CO4: Learn security issues in MANET.

Text Books:

1. J. Schiller, "Mobile Communications", Paperback, 2nd Edition, 2004
2. Stojmenovic and Cacute " Handbook of Wireless Networks and Mobile Computing", Wiley, 2002

Reference Books:

1. William Stallings "Wireless Communication and Networks" , Pearson Education
2. Raj Pandya " Mobile and Personal Communication System and Services" Prentice Hall of India, 2001
3. Hansmann , Merk, Nicklous, Stober, " Principles of Mobile Computing" Springer, 2nd edition, 2003.

Name of the Course	**Software Engineering**		
Course Code	**PHES-106**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To describe and compare various software development methods to understand the context in which each approach might be applicable
- To understand and apply the different common practices used in software industry for the analysis, design and production of software.

Section	**Course Content**
Section-A	Evolving Role of Software, Software Engineering, Changing nature of Software, Software Myths, Terminologies, Role of management in software development Software Process and desired Characteristics, Software Life Cycle Models: Build & Fix Model, Water Fall Model, Incremental Process Model, Evolutionary Process Models, Unified Process, Comparison of Models, Other Software Processes, Selection of a Model Software Requirements Analysis & Specifications: Requirements Engineering, Types of Requirements, Feasibility Studies, Requirements Elicitation, Requirements - Analysis Documentation, Validation and Management.
Section-B	Software Architecture: Its Role, Views, Component & Connector View and its architecture style, Architecture Vs Design, Deployment View & Performance Analysis, Documentation, Evaluation, Software Project Planning: Size estimation, Cost Estimation, COCOMO, COCOMO – II, Software Risk Management.
Section-C	Function Oriented Design: Design principles, Module level Concepts, Notation & Specification, Structured Design Methodology, Verification Object-Oriented Design: OO Analysis & Design, OO Concepts, Design Concepts, UML – Class Diagram, Sequence & Collaboration Diagram, Other diagrams & Capabilities,

	Design Methodology – Dynamic and Functional Modelling, Internal Classes & Operations Detailed Design: PDL, Logic/Algorithm Design, State Modelling of Classes, Verification – Design Walkthroughs, Critical Design Review, Consistency Checkers.
Section-D	Coding: Programming Principles & Guidelines, Coding Process, Refactoring, Verification Software Metrics: What & Why, Token Count, Data Structure Metrics, Information Flow Metrics, Object-Oriented Metrics, Use Case Oriented Metrics, Web Engineering Project Metrics, Metric Analysis Software Maintenance & Certification: Maintenance, Maintenance Process and Models, Estimation of Maintenance Costs, Regression Testing, Reverse Engineering, Software Re-engineering, Configuration Management, Documentation, Requirements of Certification & its Types.

Course Outcomes:

CO1: Understand and analyze the concept of software development and software engineering.

CO2: Compare and comprehend different software engineering process models.
CO3: Design of software projects and do the cost estimation.
CO4: Design applicable solutions and deliver quality software.

Text Books:

1. Pankaj Jalote, "An Integrated Approach to Software Engineering", 3rd Edition, Narosa Publishing House.
2. K.K. Aggrawal and Yogesh Singh, "Software Engineering", 3rd Edition, New Age International (P) Ltd.

Reference Books:

1. Pressman, R.S., "Software Engineering – A Practitioner's Approach", Third Edition, McGraw Hills.
2. Mall Rajib, "Fundamentals of Software Engineering", PHI, New Delhi.

Name of the Course	**Cloud Computing**		
Course Code	**PHES-107**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To provide students with the fundamentals and essentials of Cloud Computing.
- To provide students a sound foundation of the Cloud computing so that they are able to start using and adopting Cloud Computing services and tools in their real life scenarios.
- To enable students exploring some important cloud computing driven commercial systems and applications.
- To expose the students to frontier areas of Cloud Computing and information systems, while providing sufficient foundations to enable further study and research.

Section	**Course Content**
Section-A	Overview of Computing Paradigm: Recent trends in Computing ,Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. Evolution of cloud computing, Business driver for adopting cloud computing. Introduction to Cloud Computing Cloud Computing (NIST Model),Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers, Properties, Characteristics & Disadvantages, Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing. Role of Open Standards.
Section-B	Cloud Computing Architecture Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services. Service Models (XaaS): Infrastructure as a Service (IaaS),Platform as a Service(PaaS),Software as a Service(SaaS), Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community

	cloud.
Section-C	Infrastructure as a Service (IaaS): Introduction to IaaS, IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM), Resource Virtualization: Server, Storage, Network Virtual Machine (resource) provisioning and manageability, storage as a service, Data storage in cloud computing(storage as a service) Platform as a Service (PaaS): Introduction to PaaS, What is PaaS, Service oriented Architecture (SOA), Cloud Platform and Management, Computation & Storage, Software as a Service (PaaS): Introduction to SaaS, Web services, Web 2.0, Web OS, Case Study on SaaS.
Section-D	Service Management in Cloud Computing: Service Level Agreements (SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting enormously, Managing Data: Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing. Cloud Security: Infrastructure Security: Network level security, Host level security, Application level security, Data security and Storage, Data privacy and security Issues, Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Trust, Reputation, Risk Authentication in cloud computing: Client access in cloud, Cloud contracting Model, Commercial and business considerations.

Course Outcomes:

CO1: Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing.

CO2: Apply the fundamental concepts in data centres to understand the trade-offs in power, efficiency and cost.

CO3: Identify resource management fundamentals, i.e. resource abstraction, sharing and sandboxing and outline their role in managing infrastructure in cloud computing.

CO4: Analyze various cloud programming models and apply them to solve problems on the cloud.

Text Books:

1. Cloud Computing Bible, Barrie Sosinsky, Wiley-India,2010
2. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile,2011.

Reference Books:

1. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer,2012.
2. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India,2010.

Name of the Course	**Data Analytics**		
Course Code	**PHES-108**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To introduce fundamental algorithms and techniques used in Data Analytics.
- To cover statistical foundations followed by various machine learning and data mining algorithms.
- To introduce technological aspects like data management (Hadoop), scalable computation (Map Reduce) and visualization.

Section	**Course Content**
Section-A	Data Definitions and Analysis Techniques: elements, variables, and data categorization, levels of measurement, data management and indexing, introduction to statistical learning and R-programming. Descriptive Statistics: Measures of central tendency, Measures of location of dispersions, Practice and analysis with R.
Section-B	Basic Analysis Techniques: Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Practice and analysis with R.
Section-C	Data Analysis Techniques: Regression analysis, Classification techniques, Clustering, Association rules analysis.
Section-D	Case Studies and Projects: Understanding business scenarios, Feature engineering and visualization, Scalable and parallel computing with Hadoop and Map-Reduce, Sensitivity Analysis.

Course Outcomes:
CO1: Find a meaningful pattern in data and graphically interpret data
CO2: Implement the analytic algorithms.
CO3: Handle large scale analytics projects from various domains.

CO4: Develop intelligent decision support systems.

Text Books:

1. Probability and Statistics for Engineers & Scientists By Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall.
2. The Elements of Statistical Learning, Data Mining, Inference, and Prediction by Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer.

Reference Books:

1. An Introduction to Statistical Learning: with Applications in R by G James, D. Witten, T Hastie, and R. Tibshirani, Springer.
2. Mining Massive Data Sets by Jure Leskovec, Anand Rajaraman and Jeff Ullman, Cambridge University Press.

Name of the Course	**Cyber Forensics**		
Course Code	**PHES-109**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To impart knowledge about forensics and cyber laws.
- To introduce collection of evidence.
- To impart knowledge about host, network and multimedia forensics.

Section	**Course Content**
Section-A	**Introduction to Forensics:** Introduction to Incident, First Responder Procedure, Incident Response Methodology, Investigation Steps, Incident Handling, Investigation Reports, Setup of Cyber Forensics Lab, Cyber forensics Readiness, Introduction to Cyber Laws, Anti-forensics techniques.
Section-B	**Evidence Collection and Handling:** Evidence Collection from Computer, Smartphone's, IoT, Cloud. Disk Imaging- Tools, Evidence Preservation, Write Blockers, Chain of Custody, and Challenges in evidence handling, Understanding File systems - Windows, Linux, Android, and Concept of Slack space.
Section-C	**Host Forensics:** Memory Forensics, Malware Analysis, Reverse Engineering Tools, Encryption, Password Cracking, Rainbow tables, Recovery of deleted files, File carving **Network Forensics:** Introduction to network protocols, Network packet analysis, Collecting Network Based Evidence, Network Intrusion detection, Investigating Routers, Email Tracing,
Section-D	Internet Fraud. Dark Web, TOR network, Application of Big Data techniques for Log Analysis. **Multimedia Forensics and Case Studies:** Image Forensics, Video Forensics,

	Audio Forensics, Steganography, Social Media Forensics, Identity theft, Corporate espionage, Online Defamation, Online harassment, mobile forensics, memory forensics.

Course Outcomes:
CO1: Understand concepts of forensic analysis.
CO2: Perform image, video and audio forensics.
CO3: Identify possibility of tampering with the forensic evidences.
CO4: Understand cyber ethics.

Text Books:

1. Digital Evidence and Computer Crime by Eoghan Casey, Academic Press.
2. Real Digital Forensics: Computer Security and Incident Response by Keith J. Jones, Richard Bejtlich and Curtis Wayne Rose, Addison-Wesley.

Reference Books

1. File system forensic analysis by Brian Carrier, Addison-Wesley Professional.
2. Digital Forensics by André Årnes, Wiley.
3. A Practical Guide to Computer Forensics Investigations by Darren R. Hayes, Pearson IT Certification

Name of the Course	**Wireless Sensor Networks**		
Course Code	**PHES-110**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
Internal Assessment: (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			Max Marks: 50

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- Understand various components of a sensor node and discuss various applications of WSNs.
- Compare and evaluate routing protocols in wireless sensor networks.
- Understand various topology control algorithms in WSNs.
- Compare and contrast various data processing techniques used in wireless sensor networks.

Section	**Course Content**
Section-A	**Sensor networks overview:** Introduction, applications, design issues, requirements. Sensor node architecture, Architecture, and factors influencing the sensor network design.
Section-B	**Network architecture:** Optimization goals, evaluation metrics, network design principles. Sensor network operating systems and brief introduction to sensor network programming.
Section-C	**Network protocols:** MAC protocols and energy efficiency. **Routing protocols:** Data centric, hierarchical, location-based, energy efficient routing etc. Sensor deployment, scheduling and coverage issues, self configuration, and topology control.
Section-D	Querying, data collection and processing, collaborative information processing and group connectivity, Target tracking, localization and identity management. Power management. Security and privacy.

Course Outcomes:

CO1: Have an understanding of the principles and characteristics of wireless sensor networks.

CO2: Apply knowledge of wireless sensor networks to various application areas.

CO3: Analyze WSN protocols in terms of their energy efficiency and design new energy efficient protocols.

CO4: Learn security issues in wireless sensor networks.

Text Books:

1. Wireless Sensor Networks-An Information Processing Approach by Feng Zhao and Leonidas Guibas, Morgan Kauffman.
2. Wireless Sensor Networks: From Theory to Applications by Ibrahiem M. M. El Emary and S. Ramakrishnan, CRC Press.

Reference Books:

1. Wireless sensor networks by Edgar H. Callaway, AUERBACH Publications.
2. Wireless Sensor Networks: Principles and Practice by Fei Hu and Xiaojun Cao, CRC Press.
3. Protocols and Architectures for Wireless Sensor Networks by Andreas Willig and Holger Karl, Wiley Publications.