DOCTOR OF PHILOSOPHY
(Computer Science)
Ph.D. (CS)

(w.e.f. 2022-23)

Department of Computer Science and Information Technology

School of Technology

MAULANA AZAD NATIONAL URDU UNIVERSITY

1. Vision and Mission

1.1 Vision

To meet the requirements of the society by imparting knowledge, ethics and moral values with a holistic approach.

1.2 Mission

To impart quality education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens embedded with ethical values.

1.3 Strategies for Attaining the Vision and Fulfilling the Mission

Following strategies will be used to ensure the accomplishment of the stated vision and mission:

1. To create an ambiance for healthy teaching-learning process and attract the motivated students to the Department of Computer Science and Information Technology
2. Ensure that the curriculum followed is comparable to the relevance of local, national, regional and global development
3. To motivate the potential faculty members / educators who are constantly upgrading their pedagogical approaches to motivate students and to enhance learning among them
4. Provide opportunities to students for global exposure, industrial internships, project based and research-based learning

1.4 Course Work in Department of CS & IT

Department of Computer Science & Information Technology offer four courses/papers in PhD Course Work. A minimum of four credits shall be assigned to the course on Research Methodology, which shall cover areas such as quantitative methods, computer applications, research ethics and review of published research in the relevant field, training, field work, etc. Other two courses shall be advanced level courses preparing the students for PhD degree in addition to two credit course for awareness about publication ethics and publication misconducts entitled "*Research and Publication Ethics* (RPE)" made compulsory for all students for pre-registration course work as per the University Grants Commission in its 543rd meeting held on 9th august, 2019.

The following shall be the outline for course work in PhD Semester I:

- Compulsory Research Methodology Course (4 credits/100 marks)
- Compulsory Course on Broad Field of study (4 credits/100 marks)
- Compulsory Course on Research and Publication Ethics (2 credits/50 marks)

One Optional Course / Program Specific (4 credits/100 marks) shall be developed in view of the research thrust area of the Department/Centre. The Departmental Research Committee/Board of Studies of subject concerned shall decide and develop the optional courses to be offered to PhD research scholars. Each of these optional courses shall be of 4 credits (100 marks) each.

S. No.	Code	Course Name	Course Type	Credits	Mark (Internal + External)	
1	PHCS101CCT	Research Methodology	Core	4	30	70
2	PHCS102CCT	Software Engineering	Core	4	30	70
3	PHCC104CCT *(Common to all Research Scholar at University Level)*	Research and Publication Ethics (RPE)	Core	2	15	35
	Electives offered by the Department. The option for one course among the following Discipline Specific Electives					
1	PHCS101DST	Advance Computer Architecture	Program Elective / Department Specific	4	30	70
2	PHCS102DST	Advance Network Security	Program Elective / Department Specific	4	30	70
3	PHCS103DST	Neural Network	Program Elective / Department Specific	4	30	70
4	PHCS104DST	Distributed Database	Program Elective / Department Specific	4	30	70
5	PHCS105DST	Machine Learning	Program Elective / Department Specific	4	30	70
6	PHCS106DST	Fuzzy System	Program Elective / Department Specific	4	30	70
7	PHCS107DST	Advanced Operating System	Program Elective / Department Specific	4	30	70
8	PHCS108DST	Real Time System	Program Elective / Department Specific	4	30	70
9	PHCS109DST	Software Metrics	Program Elective / Department Specific	4	30	70
10	PHCS110DST	Software Quality Engineering	Program Elective / Department Specific	4	30	70

11	PHCS111DST	Wireless Mobile Networks	Program Elective / Department Specific	4	30	70
12	PHCS112DST	Nature Language Processing	Program Elective / Department Specific	4	30	70
13	PHCS113DST	Applied Cryptography	Program Elective / Department Specific	4	30	70
14	PHCS114DST	Human Computer Interaction	Program Elective / Department Specific	4	30	70
15	PHCS115DST	Bioinformatics	Program Elective / Department Specific	4	30	70
16	PHCS116DST	Information Security and Cyber Laws	Program Elective / Department Specific	4	30	70
17	PHCS117DST	Advanced Networks	Program Elective / Department Specific	4	30	70

Course Code	Course Title	Lecture			Semester: I
PHCS101CCT	Research Methodology	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand the research issues & challenges, research goals, scientific methods.
2. To provide knowledge about the scientific methods in computer science and other computer science research context
3. To study Sampling, External Validity, Levels of Measurement, Scaling and Qualitative Measures. Data Preparation, Descriptive Statistics and Correlation; and Inferential Statistics.
4. To Review Literature and Research Papers; Writing Research Papers, Thesis, Reports and Project Proposals Plagiarism and Copyrights.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the issues & challenges, goals, scientific methods in research.
CO_2	Demonstrate various computer science research context and other scientific methods in computer science.
CO_3	Apply measurements on Sampling, External Validity, Levels of Measurement, Scaling and Qualitative Measures. Data Preparation, Descriptive Statistics and Correlation; and Inferential Statistics.
CO_4	Prepare a project proposal (to undertake a project) and conduct research in a more appropriate manner, writing research report and thesis.

Detailed Contents:

Unit: 1	**Research Foundations:** Meaning of Research, Research Goals and Quality Research, Types of Research, Research Method versus Research Methodology, Research Process, Defining the Research Problem, Philosophical Worldviews: positivism/post-positivism, constructivism, transformative, pragmatism; Variables, Hypotheses, Confounded Relationship, Experimental Designs.
Unit: 2	**Literature Search, Literature Review and Research Design:** Types of publications, Measures of research impact, h-index, Databases used for citation related indices, Keywords, Summarizing literature review, Research Design: Different Research Designs, Principles of Experimental Design, Important Experimental Designs.
Unit: 3	**Sample Design, Measurement, Scaling, Data Collection & Preparation:** Sample Design: Sampling and non-sampling errors, Types of Sampling Design; Measurement: Classification of Measurement Scales, Goodness of Measurement Scales, Sources of Errors in Measurement; Scaling, Scaling Techniques, Data Collection: Primary and Secondary Data, Different Methods of Data Collection; Data Preparation: Data Preparation Process, Data Pre-processing, Feature Engineering.
Unit: 4	**Descriptive Statistics and Statistical Inference:** Descriptive Statistics: Measure of Central Tendency, Measurement of Dispersion, Measurement of Skewness, Kurtosis, Measurement of Relationship, Index Number; Statistical Inference: Central Limit Theorem, Point Estimation, Interval Estimation; ANOVA.
Unit: 5	**Research Skills:** Writing Research Papers, Research Proposal, Thesis, Reports and Project Proposals, Formatting, Appendices, Citation Formats and Style; General Conventions, Issues, Plagiarism and Copyrights.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	C.R. Kothari and Gaurav Garg, "Research Methodology: Methods and Techniques", 4th ed., New Age International Publishers, 2019

2	Catherine Dawson, Practical Research Methods: A User-Friendly Guide to Mastering Research Techniques and Projects, 5th ed., Robinson Publication, 2019
Reference Books:	
1	Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for beginners" 4th ed., SAGE Publications, 2014
2	Vinayak Bairagi, Mousami V. Munot, Research Methodology: A Practical and Scientific Approach, CRC Press, 2019

Course Code	Course Title	Lecture			Semester: I
PHCS102CCT	Software Engineering	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To gain knowledge about the fundamentals of software systems (including analysis, design, construction, maintenance, quality assurance and project management) using the appropriate theory, principles, tools and processes.
2. To understand the concept of Software Requirements Analysis & Specification in development of software systems.
3. To introduce the software design, ER-Diagram, DFD and CASE Tools in software systems.
4. To provide the knowledge about the project management techniques for a case study, coding, testing and user Interface design.

Course Outcomes (CO):

	Statement
CO_1	Understand the fundamentals of software systems (including analysis, design, construction, maintenance, quality assurance and project management) using the appropriate theory, principles, tools and processes.
CO_2	Prepare SRS documents for a software system.
CO_3	Interpret the software design, ER-Diagram, DFD and CASE Tools in software systems.
CO_4	Apply the project management techniques for a case study, coding, testing and user Interface design with project stakeholders.

Detailed Contents:

Unit: 1	**Software Engineering Fundamentals:** Definition of software product and process, Software Characteristics, Components, Applications, Layered Technologies, Processes and Product, Methods and Tools, Generic View of Software Engineering, Software Crisis, Software development paradigms, Techniques of Process Modelling, Software Process and lifecycle models: Build & Fix Model, Waterfall Model, Prototyping Model, Iterative Enhancement Model, Evolutionary Development Model and Spiral Model, Incremental, and Concurrent Development Model.
Unit: 2	**Software Requirements Analysis & Specification:** System specification, Software requirements specification (SRS) standards, Formal specification methods, Specification tools, Requirements validation and management. Problem Recognition, Evaluation and Synthesis, Modelling, Specifications and Review Techniques. Analysis Modelling: Difference between Data and Information, ER Diagram, Dataflow Model, Control Flow Model, Control and Process Specification, Data Dictionary.
Unit: 3	**Software Design:** Software architecture, Modular Design-cohesion and coupling, Process-oriented design, Process and Optimization, Data-oriented design, User-interface design, Real-time software design, Architectural Designing, Interface Design, Procedural Design, Object Oriented Design. **CASE Tools:** Computer-aided software engineering, Introduction to CASE, Building Blocks of CASE, Relevance of CASE tools, High-end and low-end CASE tools, automated support for data dictionaries, DFD, ER diagrams, Integrated Case Environment, CASE workbenches.
Unit: 4	**Coding and Testing:** Choice of Programming languages, Coding standards, Introduction to Testing Process, Functional & Structural Testing, Testing Activities like Unit, Integration & System Testing, Testing tools and workbenches. **User Interface Design:** Concepts of UI, Interface Design Model, Internal and External Design, Evaluation, Interaction and Information Display.
Unit: 5	**Configuration Management:** Concepts in Configuration Management, The Configuration **Management Process:** Planning and Setting up Configuration Management, Perform Configuration Control, Status Monitoring and Audits.

	Software Maintenance: What is software maintenance, Maintenance Process & Models, Reverse Engineering, Software re- engineering, Configuration Management issues and concept, Configuration planning & techniques, Software versions and change control process, Documentation.
Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.	
Text Books:	
1	R. Pressman, "Software Engineering", 7th Edition, 2002, McGraw-Hill.
2	W.S. Jawadekar, Software Engineering – A Primer, TMH-2008
Reference Books:	
1	Software Engineering, Yogesh Singh, New Age Publications, Delhi.
2	Shari Pfleeger, "Software Engineering", 2001, Pearson Education.

Course Code	Course Title	Lecture			
PHCC104CCT	Research and Publication Ethics (RPE)	L	T	P	**Semester:** I
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	2	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	30 Hrs.	Maximum Score	:	50
Periods/ Week	:	2	Internal Evaluation	:	15
Credits	:	2	End Semester	:	35
Instruction Mode	:	Lecture	Exam Duration	:	2 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand the philosophy of science and ethics, research integrity and publication ethics.
2. To impart research misconduct and predatory publications.
3. To provide indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.,)
4. To introduce the usage of plagiarism tools.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the philosophy, scientific conduct, Scientific misconducts, Redundant Publications and salami slicing.
CO_2	Create awareness about the publication ethics, publication misconducts and Open Access Publishing.
CO_3	Apply high standards in achieving research outcomes and use of different plagiarism software
CO_4	Find and evaluate indexing and citation databases, research metrics (citations, h-index, impact Factor, etc.,).

Detailed Contents:

Unit: 1	**PHILOSOPHY AND ETHICS:** Introduction to philosophy: definition, nature and scope, concept, branches - Ethics: definition, moral philosophy, nature of moral judgements and reactions. **SCIENTIFIC CONDUCT:** Ethics with respect to science and research - Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) - Redundant Publications: duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data.
Unit: 2	**PUBLICATION ETHICS:** Publication ethics: definition, introduction and importance - Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. - Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publisher and journals.
Unit: 3	**OPEN ACCESS PUBLISHING:** Open access publications and initiatives - SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finger / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc.
Unit: 4	**PUBLICATION MISCONDUCT:** Group Discussion: a) Subject specific ethical issues, FFP, authorship b) Conflicts of interest c) Complaints and appeals: examples and fraud from India and abroad Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.
Unit: 5	**DATABASES AND RESEARCH METRICS:** Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citations Report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 Index, altmetrics

Examination and Evaluation Pattern: It include both internal evaluation (15 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (35 marks) which is mainly end semester examination.

Text Books:

1	Bird, A.(2006). Philosophy of Science.Routledge
2	MacIntyre, Alasdair (1967) A Short History of Ethics. London

Reference Books:

1	P.Chaddah, (2018) Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized, ISBN :978-9387480865
2	National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to responsible conduct in Research: Third Edition, National Academies Press.
3	Resnik, D.B.(2011) What is ethics in research & why is it important. National institute of Environmental Health Science, 1-10 Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
4	Beall, J: (2012) Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
5	Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. htt://www.insaindia.res.in/pdf/Ethics_Book.pdf

Course Code	**Course Title**	**Lecture**			**Semester:** I
PHCS101DST	Advanced Computer Architecture	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			**Scheme of Examination**		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To learn the fundamental aspects of computer architecture design and analysis.
2. To introduce on processor design, pipelining, superscalar, out-of-order execution, caches (memory hierarchies), virtual memory, storage systems, and simulation technique.
3. To understand different processor architectures and system-level design processes.
4. To provide knowledge about Process Level Parallelism (Distributed computers, Clusters, Grid, Mainframe computers) and Peripheral Devices.

Course Outcomes (CO):

COs No.	**Statement**
CO_1	Understand fundamental aspects of computer architecture design and analysis and about computer performance, instruction set architecture design and implementation.
CO_2	Demonstrate about uniprocessor implementation alternatives (single- cycle, multiple-cycle, and pipelined implementations) etc.,
CO_3	Differentiate Centralized & Distributed shared memory, interconnection topologies and organisation and operation of current generation parallel computer systems and multiprocessor.
CO_4	Communicate with Process Level Parallelism (Distributed computers, Clusters, Grid, Mainframe computers) and Peripheral Devices.

Detailed Contents:

Unit: 1	**Review of Basic Organization and Architectural Techniques:** RISC processors, Characteristics of RISC processors, RISC Vs CISC, Classification of Instruction Set Architectures, Review of performance measurements, Basic parallel processing techniques: instruction level, thread level and process level, Classification of parallel architectures.
Unit: 2	**Instruction Level Parallelism:** Basic concepts of pipelining, Arithmetic pipelines, Instruction pipelines, Hazards in a pipeline: structural, data, and control, Hazards, Overview of hazard resolution techniques, Dynamic instruction scheduling, Branch prediction techniques, Instruction-level parallelism using software approaches, Superscalar techniques, Speculative execution.
Unit: 3	**Memory Hierarchies:** Basic concept of hierarchical memory organization, Main memories, Cache memory design and implementation, Virtual memory design and implementation, Secondary memory technology, RAID.
Unit: 4	**Thread Level Parallelism:** Centralized vs. distributed shared memory, Interconnection topologies, Multiprocessor architecture, Symmetric

	multiprocessors, Cache coherence problem, Synchronization, Memory consistency, Multicore architecture, Review of modern multiprocessors.
Unit: 5	**Process Level Parallelism:** Distributed computers, Clusters, Grid, Mainframe computers. **Peripheral Devices:** Bus structures and standards, Synchronous and asynchronous buses, Types and uses of storage devices, Interfacing I/O to the rest of the system, Reliability and availability, I/O system design, Platform architecture.
Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.	
Text Books:	
1	Hennessey and Patterson, "Computer Architecture: A quantitative Approach", Morgan Kaufman.
2	Inside the machine: an Illustrated Introduction to Microprocessors and computer archinteure, 1st Edition, by Jon Stokes
Reference Books:	
1	Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing" McGraw-Hill international Edition.
2	Kai Hwang, "Advanced Computer Architecture", Tata McGraw-Hill

Course Code	Course Title	Lecture			Semester: I
PHCS102DST	Advanced Network Security	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To learn about the threats faced by computer operating systems, applications and networks that originate from network-based attacks, intrusion and misuse
2. To understand Modular arithmetic, Euler's function, GCD, AES, Blowfish and Cryptography algorithms.
3. To acquire the knowledge of Computer-based Asymmetric Key Cryptography.
4. To impart about Public Key Infrastructure, Electronic payment systems , Session Hijacking, Spoofing, TCP, Sniffing, RDDoS, XSS Attack, etc.,

Course Outcomes (CO):

COs No.	Statement
CO_1	Gain knowledge of the threats faced by computer operating systems, applications and networks that originate from network-based attacks, intrusion and misuse
CO_2	Understand the Modular arithmetic, Euler's function, GCD, AES, Blowfish and Cryptography algorithms.
CO_3	Differentiate among Computer-based Asymmetric Key Cryptography.
CO_4	Demonstrate the Public Key Infrastructure, Electronic payment systems , Session Hijacking, Spoofing, TCP, Sniffing, RDDoS, XSS Attack, Jamming and anti-jamming techniques for wireless networks

Detailed Contents:

Unit: 1	Introduction to the Concepts of Security: The need for security, Security Approaches, Principles of Security, Types of Attacks. Cryptographic Techniques: Plain Text and Cipher Text, Substitution Techniques, Transposition Techniques, Encryption and Decryption, Symmetric and Asymmetric Key Cryptography, Steganography, Key Range and Key Size, Possible Types of Attacks.
Unit: 2	Modular arithmetic, prime numbers, relative prime numbers, Euler's function, GCD. Computer-based Symmetric Key Cryptographic Algorithms: Algorithm Types and Modes, International Data Encryption Algorithm (IDEA), RC5, Blowfish, AES, Differential and Linear Cryptanalysis.
Unit: 3	Computer-based Asymmetric Key Cryptography: Brief History of Asymmetric Key Cryptography, An overview of Asymmetric Key Cryptography, Rabin Algorithm, Elgamal Algorithm, Knapsack Algorithm, ID-based cryptography.
Unit: 4	Public Key Infrastructure: Digital Certificates, Private Key Management, The PKI Model, Internet Security Protocols: Secure Socket Layer, Secure Electronic Transaction, SHTTP, Time Stamping Protocol, 3-D Secure Protocol, Electronic payment systems: Electronic billing systems, Micropayments, Fair exchange protocols, E-mail Security.
Unit: 5	Understanding Session Hijacking, Spoofing, TCP Concepts Sequence numbers. Sniffing, RDDoS, XSS Attack, WLAN Scanners, Securing Wireless Networks, Anonymous Wireless Communication, Jamming and anti-jamming techniques for wireless networks.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Cryptography and Network Security by Behrouz A. Forouzan, 2nd Edition TMH.
2	Cryptography and Network Security, W. Stallings, Prentice Hall, 5th Edition, 20102.
3	Network Security Essentials, William Stallings, Prentice Hall, 5th Edition, 2013

Reference Books:

1	Firewalls and Internet Security, William R. Cheswick and Steven M. Bellovin, Addison-Wesley Professional, 2ndEdition, 2003.
2	Hackers Beware, Eric Core, EC-Council Press, 2003

Course Code	Course Title	Lecture			Semester: I
PHCS103DST	Neural Network	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand the role of neural networks in engineering, artificial neural networks, and cognitive modelling.
2. To provide knowledge of types of machine learning and neural network architectures.
3. To impart the knowledge of computation and dynamical systems using neural networks and artificial intelligence etc.,
4. To classify linearly separable patterns and gain the optimization and prediction techniques.

Course Outcomes (CO):

COs No.	Statement
CO_1	Demonstrate the role of neural networks in engineering, artificial neural networks, and cognitive modelling.
CO_2	Differentiate among types of machine learning and neural network architectures.
CO_3	Interpret knowledge of computation and dynamical systems using neural networks and artificial intelligence etc.,
CO_4	Apply classification, optimization and prediction techniques using different algorithms.

Detailed Contents:

Unit: 1	General characteristics of the human brain, Introduction to Biological Neural Networks, Nerve structure and synapse, Basic concepts of Neural Networks, Characteristics of Neural Networks, Terminologies, Applications of the artificial neural networks.
Unit: 2	Structure of a neural net (topology), Directed graphs, Models of Neuron, Neural Network Architectures, Artificial Neuron, Activation functions, Threshold function, Piecewise linear function, Sigmoidal function, Supervised learning, Unsupervised learning, Re-inforcement learning.
Unit: 3	Knowledge Representation, Artificial Intelligence, learning rules, Error correction learning, Memory based learning, Hebbian learning, Competitive learning, Boltzmann learning, Single layer perceptron, Multilayer perceptron, Back propagation, Recurrent networks, Network Pruning.
Unit: 4	Adaptive networks, Supervised Learning Neural Networks, Decision-based neural networks, Hierarchical neural networks, Probabilistic neural network, Radial basis function networks, Comparison of RBF Networks and Multilayer perceptron.
Unit: 5	Classification of linearly separable patterns, Boltzmann machine, Sigmoid Belief Networks, Helmholtz machine, Support vector machines, Self-organization maps, Genetic Algorithms, Optimization, Prediction Systems, speech and decision-making.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	S. Haykin, "Neural Networks a comprehensive Foundation" second edition, Prentice-Hall India.
2	Laurene Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Prentice Hall, 1993.
3	Michael A Arbib, "The Handbook of Brain Theory and Neural Networks", Second Edition, MIT Press

Reference Books:

1	Jacek M. Zurada, Introduction to artificial neural systems, Jaico Publ. House, 1994.
2	Anderson, —An introduction to Artificial Neural Networks‖, Prentice Hall
3	B. Yegnanarayana, —Artificial Neural Networks‖, PHI

Course Code	Course Title	Lecture			Semester: I
PHCS104DST	Distributed Database	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To learn about distributed transaction principles for handling transactions in distributed database applications, testing for Serializability and centralized database systems.
2. To introduce different protocols (Lock based protocols, time stamp-based protocol et.,) in distributed database.
3. To provide the techniques used for data fragmentation, replication, and allocation during the distributed database design process.
4. To impart the query optimization principles for optimizing query performance in centralized and distributed database systems.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the distributed transaction principles for handling transactions in distributed database applications, Testing for Serializability and centralized database systems.
CO_2	Differentiate among the protocols (Lock based protocols, time stamp-based protocol et.,) in distributed database.
CO_3	Design techniques used for data fragmentation, replication, and allocation during the distributed database design process.
CO_4	Apply the query optimization principles for optimizing query performance in centralized and distributed database systems

Detailed Contents:

Unit: 1	Transaction and schedules, Concurrent Execution of transaction, Conflict and View Serializability, Testing for Serializability, Concepts in Recoverable and Cascade less schedules.
Unit: 2	Lock based protocols, time stamp-based protocols, Multiple Granularity and Multisession Techniques, enforcing serializability by Locks, multiple lock modes, Architecture for locking scheduler.
Unit: 3	Introduction to distributed databases, advantages and disadvantages of distributed database, additional functions of Distributed database, distributed DBMS, Distributed Transactions Management, Fragmentation and Replication Techniques, Fragmentation schema, allocation schema data replication.
Unit: 4	Recovery and atomicity in Distributed Databases, Traditional recovery techniques, Log based recovery, recovery techniques used for ensuring atomicity, Recovery with Concurrent Transactions, Checkpoints, Algorithm for recovery.
Unit: 5	Distributed Query Processing, Semi joins, general queries Cost based query optimization for Distributed database, integrity constraints in distributed database, Distributed Deadlock.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Silberschatz, orth and Sudershan, Database System Concept, Mc Graw Hill
2	David Bell, Jane Grimson, Distributed Database Systems, Addison-Wesley

Reference Books:

1	Garcia-Molina, Ullman,Widom,' Database System Implementation' Pearson Education
2	Ceei and Pelagatti,'Distributed Database', TMH. M.Tamer Ozsu, 'Principles of distributed database Systems' second edition Pearson education

Course Code	Course Title	Lecture			Semester: I
PHCS105DST	Machine Learning	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand the basic building blocks and general principles that allows one to design machine learning algorithms.
2. To familiar with specific, widely used machine learning algorithms.
3. To learn methodology and tools to apply machine learning algorithms to real data.
4. To provide the evaluation of performance of different machine learning algorithms.

Course Outcomes (CO):

COs No.	Statement
CO_1	Demonstrate the basic building blocks and general principles that allows one to design machine learning algorithms.
CO_2	Understand the specific, widely used machine learning algorithms.
CO_3	Apply methodology and tools to apply machine learning algorithms to real data.
CO_4	Evaluate the learning algorithms and model selection.

Detailed Contents:

Unit: 1	Introduction: Defining learning systems, Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation, supervised learning, unsupervised learning, Reinforcement learning, learning algorithms.
Unit: 2	Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity, Overfitting, noisy data, and pruning.
Unit: 3	Ensemble Learning: Bagging, boosting, and Ada-Boost. Experimental Evaluation of Learning Algorithms, Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.
Unit: 4	Rule Learning: Translating decision trees into rules. Artificial Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and back propagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.
Unit: 5	Support Vector Machines: Maximum margin linear separators. Kernels for learning non-linear functions. Bayesian Learning: theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logisitic regression. Bayes nets and Markov nets for representing dependencies. Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor algorithm, Case-based learning

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Machine Learning – Tom M. Mitchell, - MGH
2	Machine Learning: An Algorithmic Perspective, Stephen Marsland, Taylor & Francis (CRC)

Reference Books:

1	Machine Learning Methods in the Environmental Sciences, Neural Networks, William W Hsieh, Cambridge University Press.
2	Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc., 2001
3	Chris Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995

Course Code	Course Title	Lecture			Semester: I
PHCS106DST	Fuzzy System	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	30 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand basic knowledge of fuzzy sets and fuzzy logic.
2. To introduce different Fuzzy relations, fuzzy information representation and processing.
3. To gain knowledge of different neural network architectures, their limitations and appropriate learning rules for each of the architectures.
4. To impart the knowledge of Fuzzy Expert Systems, Fuzzy Neural Networks, Fuzzy Automata Fuzzy Dynamic Systems and Fuzzy Databases etc.,.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the basic concepts of fuzzy sets and fuzzy logic.
CO_2	Demonstrate knowledge of fuzzy system as they apply in engineering and science and their fuzzy relations.
CO_3	Differentiate among type neural network architectures, their limitations and appropriate learning rules for each of the architectures.
CO_4	Interpret the Fuzzy Expert Systems, Fuzzy Neural Networks, Fuzzy Automata Fuzzy Dynamic Systems and Fuzzy Databases etc.,

Detailed Contents:

Unit: 1	Introduction, Basic Types, Basic Concepts, Representations of Fuzzy Sets, Extension Principle for Fuzzy Sets, Types of Operations. Fuzzy Complements, Fuzzy Intersections: t- Norms. Fuzzy Unions: t-Conorms, Combinations of Operations. Aggregation Operations. Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals, Arithmetic Operations on Fuzzy Numbers, Fuzzy Equations.
Unit: 2	Crisp versus Fuzzy Relations, Projections and Cylindric Extensions, Binary Fuzzy Relations, Binary Relations on a Single Set. Fuzzy Equivalence Relations, Fuzzy Compatibility Relations. Fuzzy Ordering Relations, Fuzzy Morphisms, Sup-i Compositions of Fuzzy Relations, Compositions of Fuzzy Relations.
Unit: 3	Fuzzy Measures, Fuzzy Sets and Possibility Theory, Classical Logic: An Overview. Multivalued Logics. Fuzzy Propositions. Fuzzy Quantifiers. Linguistic Hedges. Inference from Conditional Fuzzy Propositions. Inference from Conditional and Qualified Propositions. Inference from Quantified Propositions, Information and Uncertainty, Nonspecificity of Fuzzy Sets. Fuzziness of Fuzzy Sets. Principles of Uncertainty.
Unit: 4	Fuzzy Expert Systems: An Overview. Fuzzy Implications. Selection of Fuzzy Implications. Multiconditional Approximate Reasoning. The Role of Fuzzy Relation Equations, Fuzzy Controllers: Overview, Fuzzy Neural Networks. Fuzzy Automata. Fuzzy Dynamic Systems.
Unit: 5	Fuzzy Databases. Fuzzy Information Retrieval, Individual Decision Making, Multiperson Decision Making, Multicriteria Decision Making, Multistage Decision Making, Fuzzy Systems and Genetic Algorithms.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	George J. Klir, Bo Yuan, "Fuzzy Sets and Fuzzy Logic", PHI
2	James K. Peckol, “Introduction to Fuzzy Logic”, Wiley

Reference Books:

1	Witold Pedrvcz and Femando Gomide. "An Introduction to Fuzzy Sets", PHI
2	Jerry M. Mendel, “Uncertain Rule-based Fuzzy Systems”, Springer

Course Code	Course Title	Lecture			
PHCS107DST	Advanced Operating System	L	T	P	**Semester:** I
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To learn about the operating system concepts, thread model with implementation.
2. To introduce the concepts of inter process communication, scheduling and synchronization in operating system.
3. To understand Deadlocks with its avoidance & prevention and Memory and device management.
4. To provide the depth knowledge of distributed operating systems and real time operating systems.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the concept of operating system along with thread model which includes implementation.
CO_2	Interpret various process management concepts including scheduling, synchronization, deadlocks.
CO_3	Find the Deadlocks with its avoidance & prevention and understand the Memory and device management.
CO_4	Identify different types of operating systems including UNIX, distributed operating systems and real time operating systems.

Detailed Contents:

Unit: 1	**Introduction:** Operating system concept - processes and threads, process model, process creation, process termination, process hierarchies, and process states, Implementation of processes, Threads- Thread model, thread usage, Implementation of threads in user space and kernel, Hybrid implementations.
Unit: 2	**Inter Process Communication:** Race conditions, critical regions, Mutual Exclusion with busy waiting, sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing; Scheduling- scheduling in batch systems, Interactive systems, Real time systems, Thread scheduling.
Unit: 3	**Deadlocks:** Introduction, Deadlock Detection and Recovery – Deadlock Detection with one resource of each type, with multiple resource of each type, recovery from deadlock; Deadlock Avoidance, Deadlock Prevention.
Unit: 4	**Memory and Device Management:** Introduction, Swapping, Paging, Virtual memory – Demand paging, page replacement Algorithms; File System Management- Organization of File System, File Permissions, MS DOS and UNIX file system case studies, NTFS; Device Management- I/O Channels, Interrupts and Interrupt Handling, Types of device allocation.
Unit: 5	**Distributed Operating Systems:** Distributed operating system concept – Architectures of Distributed Systems, Distributed Mutual Exclusion, Distributed Deadlock detection, Agreement protocols, Threads, processor Allocation, Allocation algorithms, Distributed File system design; Real Time Operating Systems: Introduction to Real Time Operating Systems, Concepts of scheduling, Real time Memory Management.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Mukesh Singhal and Niranjan, "Advanced Concepts in Operating Systems", TMH, 1st Edition, 2001.
2	Andrew S. Tanenbaum, "Modern Operating Systems", Pearson Education, 2nd Edition, 2006

Reference Books:

1	Andrew S. Tanenbaum, "Distributed Operating Systems", Pearson Education, 2nd Edition, 2001.
2	Pradeep K. Sinha, "Distributed Operating Systems and concepts", PHI, First Edition, 2002

Course Code	Course Title	Lecture			Semester: I
PHCS108DST	Real Time System	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand the basic concepts of Real Time Systems and resource allocation techniques of Real Time Systems.
2. To introduce the features specific for Real Time Systems and real time design principles.
3. To discuss the various issues involved in Real Time System design and development.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the basic concepts of Real Time Systems and resource allocation techniques of Real Time Systems.
CO_2	Identify the features specific for Real Time Systems, real time design principles and various real time design principles.
CO_3	Apply different design techniques and for better quality considerations.
CO_4	Analyse the various risks and issues associated with real time system design and development.

Detailed Contents:

Unit: 1	**Real-time systems:** Real-time systems models, Types of real-time systems, internal structure of real-time systems, Performance measures, Examples of real-time systems and real-world applications, Modelling & Designing real-time systems.
Unit: 2	**Real-Time Process Management:** Task scheduling for Uniprocessor systems, handling priorities with critical section, interrupts, task allocation & scheduling for multiprocessor systems, adaptive scheduling.
Unit: 3	**Programming Environment:** In depth Knowledge of RTOS programming languages, tools & techniques.
Unit: 4	**Real-Time System Design:** Design techniques for Reliability, Fault Tolerance & other application specific quality considerations.
Unit: 5	Trends in Real-Time System Design & Development in fields such as Robotics. Introduction to research topics.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	A.C. Shaw, Real-Time Systems and Software, Wiley.
2	J.E. Cooling, Real-Time Software Systems, International Thompson Computer Press
3	Real-Time Systems Design and Analysis, P.H. Laplante, IEEE Press

Reference Books:

1	Real-Time Systems, J. Liu, Prentice-Hall, 2000
2	Real-Time Computer Control, R. Bennett, Prentice-Hall
3	Real-Time Systems, C.M. Krishna and K.G. Shin, McGraw-Hill

Course Code	Course Title	Lecture			Semester: I
PHCS109DST	Software Metrics	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand concept of Software Metrics and software quality assurance framework.
2. To provide the examples of where Metrics are used and explain some of the issues with Software Metrics.
3. To impart the measuring structure and size of software metrics.
4. To gain the knowledge of object oriented metrics.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand Software Metrics concepts and software quality assurance framework.
CO_2	Identify the examples of where Metrics are used and explain some of the issues with Software Metrics.
CO_3	Evaluate the measurement of structure and size of software metrics.
CO_4	Analyze the object oriented metrics.

Detailed Contents:

Unit: 1	**Software Quality Assurance Framework:** What is Quality? Software Quality Assurance, Components of Software Quality Assurance, Software Quality Assurance Plan. Steps to develop and implement a Software Quality Assurance Plan.
Unit: 2	**Quality Standards:** ISO 9000 and Comparison ISO Standards, CMM, CMMI, PCMM, 3 Sigma, 6 Sigma, Software Quality Models.
Unit: 3	**Measurement basics:** What is Software Metrics?, Application Areas of Metrics, Categories of Metrics, Measurement Scale, Axiomatic Evaluation of Metrics on Weyuker's Properties. Analyzing the Metric Data: Summary statistics for preexamining data, Metric Data Distribution, Outlier Analysis, Correlation Analysis, Exploring Analysis.
Unit: 4	**Measuring Structure and Size:** Size Estimation, Halstead Software Science Metrics, Information flow Metrics, Measuring Quality, Software Quality metrics based on Defects, Usability Metrics, Testing Metrics, Reliability Models.
Unit: 5	**Object Oriented Metrics:** Coupling Metrics, Cohesion Metrics, Inheritance Metrics, Size Metrics, Reuse Metrics, Empirical software engineering, research in software quality

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Pearson Education (Singapore) Pvt. Ltd., 2002.
2	Norman E. Fenton and Shari Lawrence, "Software Metrics", PfleegerThomson, 2003.
3	D. Galin, "Software Quality Assurance: From Theory to Implementation", Addison Wesley.

Reference Books:

1	Allan C. Gillies, "Software Quality: Theory and Management", Thomson Learning, 2003
2	Mike Konrad and Sandy Shrum, CMMI, Mary Beth Chrissis, Pearson Education (Singapore) Pvt Ltd, 2003
3	Mordechai Ben Menachem/Garry S. Marliss, "Software Quality", Thomson Learning.

Course Code	Course Title	Lecture			Semester: I
PHCS110DST	Software Quality Engineering	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To learn approaches to quality assurance, Understand quality models.
2. To evaluate the system based on the software quality metrics, in-process quality metrics and software maintenance.
3. To introduce software quality management and software quality assessment models.
4. To impart the test design and identify applicable measurements for the verification and validation effort.

Course Outcomes (CO):

COs No.	Statement
CO_1	Find different approaches to test software applications Analyse specifications, quality assurance and identify appropriate test generation strategies.
CO_2	Evaluate the system based on the software quality metrics, in-process quality metrics and software maintenance.
CO_3	Interpret software quality management and software quality assessment models.
CO_4	Apply the test design and measurements for the verification and validation effort.

Detailed Contents:

Unit: 1	**Introduction:** Defining Software Quality, Software Quality Attributes and Specification, Cost of Quality, Defects, Faults, Failures, Defect Rate and Reliability, Defect Prevention, Reduction, and Containment, Overview of Different Types of Software Review, Introduction to Measurement and Inspection Process, Documents and Metrics.
Unit: 2	**Software Quality Metrics:** Product Quality Metrics: Defect Density, Customer Problems Metric, Customer Satisfaction Metrics, Function Points, In-Process Quality Metrics: Defect Arrival Pattern, Phase-Based Defect Removal Pattern, Defect Removal Effectiveness, Metrics for Software Maintenance: Backlog Management Index, Fix Response Time, Fix Quality, Software Quality Indicators.
Unit: 3	**Software Quality Management and Models:** Modelling Process, Software Reliability Models: The Rayleigh Model, Exponential Distribution and Software Reliability Growth Models, Software Reliability Allocation Models, Criteria for Model Evaluation, Software Quality Assessment Models: Hierarchical Model of Software Quality Assessment.
Unit: 4	**Software Quality Assurance:** Quality Planning and Control, Quality Improvement Process, Evolution of Software Quality Assurance (SQA), Major SQA Activities, Major SQA Issues, Zero Defect Software, SQA Techniques, Statistical Quality Assurance, Total Quality Management, Quality Standards and Processes.
Unit: 5	**Software Verification, Validation & Testing:** Verification and Validation, Evolutionary Nature of Verification and Validation, Impracticality of Testing all Data and Paths, Proof of Correctness, Software Testing, Functional, Structural and Error-Oriented Analysis & Testing, Static and Dynamic Testing Tools, Characteristics of Modern Testing Tools.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Jeff Tian, Software Quality Engineering (SQE), Wiley-Interscience, 2005; ISBN 0-471-71345-7.
2	Witold Suryn, "Software Quality Engineering " wiley

Reference Books:

1	Metrics and Models in Software Quality Engineering, Stephen H. Kan, Addison- Wesley (2002), ISBN: 0201729156.
2	Ronald Kirk Kandt, "Software Engineering Quality Practices" CRC

Course Code	Course Title	Lecture			Semester: I
PHCS111DST	Wireless Mobile Networks	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To learn about the basics of wireless communication & how communication takes place in wireless networks.
2. To understand the Cellular communication, G.S.M and CDMA.
3. To Gain Knowledge about the Mobile TCP, Wi-Fi and WiMAX.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the basics of wireless communication & how communication takes place in wireless networks.
CO_2	Demonstrate the characteristics of mobile/wireless communication channels Cellular communication, G.S.M and CDMA.
CO_3	Gain acquaintance in the mobile communication systems like security and privacy etc.
CO_4	Differentiate among the Mobile TCP, Wi-Fi and WiMAX and pursue research in the area of wireless communication.

Detailed Contents:

Unit: 1	Introduction, Fundamentals of cellular systems, mobile ad-hoc and sensor networks, wireless PAN/LAN/MAN. Overview of probability theory, traffic theory, queuing theory, and discrete event driven simulations.
Unit: 2	Mobile radio propagation, multi-path propagation, path loss, slow fading, fast fading. Channel coding and Error Control Techniques. Cellular concept, frequency reuse, cell splitting, cell sectoring.
Unit: 3	Multiple radio access protocols, CSMA, CSMA/CD, CSMA/CA. Static and dynamic channel allocation techniques.
Unit: 4	Mobile Communication Systems: Registration, Roaming, Multicasting, Security and Privacy. Optical Networking.
Unit: 5	Wireless sensor networks, MAC protocols for wireless sensor networks, routing in sensor networks. Wireless PAN (Bluetooth), Wireless LAN (Wi-Fi), Wireless MAN (WiMAX)

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Dharma Prakash Agrawal and Qing-An Zeng, *Introduction to Wireless and Mobile Systems*, Tomson, 2010, 3rd edition (ISBN-13: 978-1-4390-6205-0; ISBN-10: 1-4390-6205-6).

Reference Books:

1	Vijay K. Grag and Joseph E. Wilkes, *Wireless and Personal Communications Systems*, 1996 (ISBN: 0-13-234626-5).
2	Christian Huitema, *Routing in the Internet*, Prentice Hall, 1995 (ISBN: 0-13-132192-7).

Course Code	Course Title	Lecture			Semester: I
PHCS112DST	Natural Language Processing	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand natural language processing and computational linguistics.
2. To acquainted with the algorithmic description of the main language levels: morphology.
3. To provide methodology for evaluating NLP systems.
4. To impart a simple NLP system to solve real life problem.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand natural language processing and computational linguistics.
CO_2	Demonstrate Regular Expressions and Morphology.
CO_3	Apply the methodology for evaluating NLP systems.
CO_4	Implement a simple NLP system to solve real life problem.

Detailed Contents:

Unit: 1	**Introduction:** Introduction to the Morphology, Syntax, Semantics by linking the "linguistics view" (computational linguistics) with the "artificial intelligence view" (natural language processing).
Unit: 2	**Overview And Morphology:** Introduction – Models -and Algorithms - -Regular Expressions Basic Regular Expression Patterns – Finite State Automata. Morphology - Inflectional Morphology - Derivational Morphology. Finite-State Morphological Parsing -- Porter Stemmer
Unit: 3	**Word Level And Syntactic Analysis:** N-grams Models of Syntax - Counting Words - Unsmoothed N-grams Smoothing- Backoff DeletedInterpolation – Entropy - English Word Classes - Tagsets for English Part of Speech Tagging-Rule Based Part of Speech Tagging - Stochastic Part of Speech Tagging - Transformation-Based Tagging
Unit: 4	**Semantic Analysis:** Representing Meaning - Meaning Structure of Language - First Order Predicate Calculus. Representing Linguistically Relevant Concepts - SyntaxDriven Semantic Analysis - Semantic Attachments -SyntaxDriven Analyzer. Robust Analysis - Lexemes and Their Senses - Internal Struct ure - Word SenseDisambiguation -Information Retrieval
Unit: 5	**Language Generation And Discourse Analysis:** Discourse -Reference Resolution - Text Coherence - Discourse Structure – Coherence. Dialog and Conversational Agents - Dialog Acts – Interpret ation - Conversational Agents. Language Generation – Architecture - Surface Realizations - Discourse Planning Machine Translation -Transfer Metaphor–Interlingua – Statistical Approaches

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.
2	Chris Manning and Hinrich Schütze, "*Foundations of Statistical Natural Language Processing*", MIT Press. Cambridge, MA: May 1999.

Reference Books:

1	Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2	Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

Course Code	Course Title	Lecture			Semester: I
PHCS113DST	Applied Cryptography	L	T	P	
Version: 1.2	Date of Approval: 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand how cryptographic algorithms keys and protocols, and an appropriate hardware (software) environment can solve security problem (confidentiality, integrity, authenticity).
2. To learn how security is achieved in real life systems in areas of telecom, government/identity, buildings/transportation, payment.
3. To study real-life applications of encryption, Message Authentication Codes (MAC) and Digital Signatures in smart cards and terminals, personal identity and crypto currency systems.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand how security problems are solved in the industry, and understanding why specific choices are made.
CO_2	Interpret security (attacks and defences) in complex real-life systems and the role of keys, cryptographic algorithms and protocols, tamper resistant hardware and other types of countermeasures
CO_3	Demonstrate about the entity authentication and data authentication, challenge-response
CO_4	Apply the advance cryptography like ECC, DNA cryptography and Digital Signature.

Detailed Contents:

Unit: 1	Basic Encryption and Decryption: introduction to Ciphers, Monoalphabetic Substitutions such as the Caesar Cipher, Cryptanalysis of Monoalphabetic Ciphers, Polyalphabetic Ciphers such as Vigenere Tableaux, Cryptanalysis of Polyalphabetic Ciphers, Perfect Substitution Cipher such as the Vernam Cipher, Stream and Block Ciphers.
Unit: 2	Encryption; authentication; symmetric cryptography, asymmetric cryptography: public-key cryptosystems; digital signatures, message authentication codes. Steganography, One-way functions; pseudo-randomness and random number generators.
Unit: 3	Remote user authentication, notions of security; zero knowledge/ interactive proofs, multi-party cryptographic protocols, key exchange and applications.
Unit: 4	Cryptanalysis of cryptographic primitives and protocols, such as by side-channel attacks, differential cryptanalysis, or replay attacks; and cryptanalytic techniques on deployed systems.
Unit: 5	Advanced Topics - ECC, DNA cryptography, quantum cryptography, Digital Watermarking. Digital signatures: Definitions and applications, Lamport and Merkle schemes. overview of signatures based on discrete-log. certificates and trust management. , SSL/TLS and IPsec, Privacy mechanisms.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Handbook of Applied Cryptography by A. Menezes, P. Van Oorschot, S. Vanstone.
2	Cryptography by Behrouz A. Forouzan, TMH
3	Cryptography and Network Security by Stalling, PHI

Reference Books:

1	Cryptography & security services, Mechanism & application By Mogollon, Manuel, Cyber tech. Pub.
2	Cryptography and hardware security By Stalling, W PHI.

Course Code	Course Title	Lecture			Semester: I
PHCS114DST	Human Computer Interaction	L	T	P	
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To provides a basic understanding of Human interfaces, their design principles, tools as well as interfaces through thought process
2. To learn the design principles of developing a Human Computer Interface.
3. To Study of tools and devices required for designing a good interface

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand fundamental design and evaluation methodologies of human computer interaction.
CO_2	Demonstrate knowledge of human computer interaction design concepts and related methodologies.
CO_3	Design the interface metaphors and social mechanisms conceptual framework.
CO_4	Apply theories and concepts associated with effective work design to real-world application.

Detailed Contents:

Unit: 1	**Introduction:** Importance of user Interface –Characteristics of graphical and web user interfaces, importance of good design. Benefits of good design, Principles of good Screen design.
Unit: 2	System menus and navigation schemes, kinds of windows, device-based controls, screen-based controls, test and messages.
Unit: 3	Feedback, guidance and assistance, Internationalization and Accessibility, graphics, icons and images, colours, layout windows and pages.
Unit: 4	**Interaction design** - introduction, goals, usability. Conceptualizing interaction problem space, conceptual models, interface metaphors, interaction paradigms, cognition, conceptual framework for cognition, collaboration, communication, social mechanisms conceptual frame work.
Unit: 5	Affective aspects, Expressive interface, user frustration agents process of interaction design, activities, characteristics, practical issues, life cycle models, design, prototyping and conceptual design, physical design, evaluation, framework, testing modelling users-kinds of tests, doing user testing, experiments, predictive model.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	The essential guide to user interface design, Wilbert O Galitz, Wiley DreamTech. Designing the user interface. 3rd Edition Ben Sheidermann, Pearson Education Asia.
2	Preece, Rogers, Sharp, "interaction design", John Wiley 2002
3	Human – Computer Interaction. Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg, Pearson Education

Reference Books:

1	Sheiderman B Desiging the user interface, "Strategies for Effective Human Computer Interaction" , 2nd ed. Addison Wesley , 1992 Pub.
2	Sudifte AG , "Human Computer Interface Design" , 2nd ed, Macmillan ,1995

Course Code	Course Title	Lecture			Semester:
PHCS115DST	Bioinformatics	L	T	P	I
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand the new field of bioinformatics (computational biology).
2. To learn how machine learning techniques can be employed in this area.
3. To provide knowledge about modern bioinformatics applications, particularly those which make good use of pattern recognition and machine learning methods

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand modern molecular biology and genomics.
CO_2	Demonstrate the advantages and disadvantages of different machine learning techniques in bioinformatics and how the relative merits of different approaches can be evaluated by correct benchmarking techniques.
CO_3	Evaluate the relative merits of different approaches by correct benchmarking techniques.
CO_4	Find how theoretical approaches can be used to model and analyse complex biological systems.

Detailed Contents:

Unit: 1	**Introduction: biology, physics:** Biological hierarchy, Information stages, Physical processes, **Methods of gene sequencing:** Detailed discussion on Sequences searching methods.
Unit: 2	**Gene expression:** Current and prospective methods of gene profiling. Data acquisition. Data standardization. Linear approximations of data; DNA chips, Protein targeting, Data normalization, Linear view.
Unit: 3	**Statistics approaches:** Probabilistic notions, Multivariate issues, Clustering, Information handling, Experimental and computational methods of structure determination for proteins and nucleic acids.
Unit: 4	**Ontology:** Annotation of genes, their products and functions. System biology, evolution, hierarchy, medical informatics, Software support: Software availability, Software targets, Text parsing, BioPerl. Statistics, R-system.
Unit: 5	**Recent Advances & Applications of Bio-Informatics:** Recent trends in Computing with bio-systems.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	David W. Mount, "Bioinformatics, Sequence and Genome Analysis", Cold Spring Harbor Laboratory Press.
2	Andreas D. Baxevanis, "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", Second Edition
3	D.E. Krane and M.L. Raymer, "Fundamental Concepts of Bioinformatics", Pearson Education, 2003

Reference Books:

1	B. Bergeron, "Bioinformatics Computing", Prentice –Hall, 2003.
2	Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, "Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids", Cambridge University Press

Course Code	Course Title	Lecture			Semester:
PHCS116DST	Information Security and Cyber Laws	L	T	P	I
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To understand the skills to imbibe the Information Security issues at technological ground and then relate it to complex cyber world legal problems.
2. To impart a detailed understanding of national and international regulatory paradigms and its mechanics regarding Cyber Law.
3. To study of cyber-security and the regulation of the Internet and the Internet of Things.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the structure, mechanics and evolution of the Internet in the context of emerging crime threats and technological and other trends in cyberspace.
CO_2	Evaluate the effectiveness of cyber-security, cyber-laws (e.g. the Budapest Convention) and other countermeasures against cybercrime and cyber warfare.
CO_3	Demonstrate the Trade mark Registration Process, Trade mark maintenance and Copyrights.
CO_4	Differentiate among the different theoretical and cross-disciplinary approaches (criminological, political, legal and information security/management).

Detailed Contents:

Unit: 1	Changing Nature of Information Systems, Need of Distributed Information Systems, Role of Internet and Web Services, Information System Threats and attacks, Classification of Threats and Assessing Damages 18 Security in Mobile and Wireless Computing- Security Challenges in Mobile Devices, authentication Service Security, Security Implication for organizations, Principles of Information Security: Confidentiality, Integrity Availability and other terms in Information Security.
Unit: 2	Security Threats to E Commerce, Virtual Organization, Business Transactions on Web, E Governance and EDI, Concepts in Electronics payment systems, E Cash, Credit/Debit Cards. Biometrics, Factors in Biometrics Systems, Benefits, Criteria for selection of biometrics, Design Issues in Biometric Systems.
Unit: 3	Model of Cryptographic Systems, Issues in Documents Security, System of Keys, Public Key Cryptography, Digital Signature, Requirement of Digital Signature System, Finger Prints, Firewalls: Design and Implementation Issues, Policies.
Unit: 4	IT Act; The rights the various parties have with respect to creating, modifying, using distribution. Computer Software and Intellectual Property-Objective, Copyright Protection, Reproducing, Defenses, Patent Protection. Database and Data Protection-Objective.
Unit: 5	Introduction to Trade mark – Trade mark Registration Process – Post registration Procedures – Trade mark maintenance. Introduction to Copyrights – Principles of Copyright Principles -The subjects Matter of Copy right – The Rights Afforded by Copyright Law – Copy right Ownership. Introduction to Trade Secret – Maintaining Trade Secret.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Godbole," Information Systems Security", Willey
2	Merkov, Breithaupt," Information Security", Pearson Education
3	Sood,"Cyber Laws Simplified", Mc Graw Hill

Reference Books:

1	Furnell, "Computer Insecurity", Springer
2	Schou, Shoemaker, " Information Assurance for the Enterprise", Tata McGraw Hill
3	IT Act 2000

Course Code	Course Title	Lecture			Semester:
PHCS117DST	Advanced Networks	L	T	P	I
Version: 1.2	**Date of Approval:** 16th BoS 17-11-2022	4	0	0	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

The course is intended to provide:

1. To learn a broad coverage of introductory and advanced topics in the field of computer networks.
2. To provide depth knowledge of computer networks.
3. To recognize the different internetworking devices and their functions.

Course Outcomes (CO):

COs No.	Statement
CO_1	Understand the services and features of the various layers of data networks.
CO_2	Design, calculate, and apply subnet masks and addresses to fulfil networking requirements.
CO_3	Analyse the features and operations of various application layer protocols such as Http, DNS, and SMTP.
CO_4	Apply the routing architecture and routing between peers etc.

Detailed Contents:

Unit: 1	Requirements, Network architecture, Networking principles, Network services and Layered architecture, Network services and Layered architecture, Future networks (Internet, ATM, Cable TV, Wireless – Bluetooth, Wi-Fi, WiMax, Cell phone)
Unit: 2	Virtual circuits, Fixed size packets, Small size packets, Integrated service, History, Challenges, ATM Network protocols, IP over ATM, Wireless networks: Wireless communication basics, architecture, mobility management, wireless network protocols. Ad-hoc networks Basic concepts, routing; Bluetooth (802.15.1), Wi-Fi (802.11), WiMAX (802.16), Optical Network: links, WDM system, Optical LANs, Optical paths and networks.
Unit: 3	Control of networks: objectives and methods of control, Circuit switched networks, ATM networks. Mathematical background for control of networks like Circuit switched networks, Datagram and ATM networks.
Unit: 4	Routing architecture, Routing between peers (BGP) , IP switching and Multi-Protocol Label Switching (MPLS), MPLS Architecture and related protocols, Traffic Engineering (TE) and TE with MPLS, NAT and Virtual Private Networks (L2, L3, and Hybrid), CIDR –Introduction, CIDR addressing, CIDR address blocks and Bit masks.
Unit: 5	Mobile IP- characteristics, Mobile IP operation, Security related issues. Mobility in networks, Voice and Video over IP (RTP, RSVP, QoS) IPv6: Why IPv6, basic protocol, extensions and options, support for QoS, security, etc., neighbour discovery, auto-configuration, routing. Application Programming Interface for IPv6.

Examination and Evaluation Pattern: It include both internal evaluation (30 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (70 marks) which is mainly end semester examination.

Text Books:

1	Tanenenbaum, " Computer Network",PHI.

Reference Books:

1	Srinivasan Keshav" An Engineering Approach To Computer Networking ",Pearson
2	D. Bertsekas , R Gallagar ,"Data Networks and Internets" PHI.