University Institute of Technology (UIT)

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

(NAAC Accredited "A-Grade" University)

DEPARTMENT of INFORMATION TECHNOLOGY

Course Work Syllabus

for

Doctor of Philosophy

in

Information Technology

Effective from the Session 2021-2022

SCHEME AND SYLLABI FOR PH. D DEGREE PROGRAMME

(Information Technology) Semester 1 coursework

Subject Code	Subject	Schedule of Teaching			Schedule of Examination		
		L	P	Credits	TA	ESE	Total
HSMC	Research Methodology	4	0	4	50	100	150
	Elective 1	4	0	4	50	100	150
	Elective 2	4	0	4	50	100	150

Note: For candidates who have studied Research Methodology as a subject in M. Tech. need not appear for exams. The credits earned by them in this course in M. Tech. will be considered for PhD.

Subject Code	Subject	Schedule of Teaching			Schedule of Examination		
		L	P	Credits	TA	ESE	Total
	Project proposal writing and presentation	0	0	4			
	Review article writing	0	0	4			
Electives							
PHES101	Digital Video Processing						
PHES102	Pattern Recognition						
PHES103	Computational Aspects of Bioinformatics						
PHES104	Cognitive Computation						
PHES105	Augmented Reality and Virtual Reality						
PHES106	Machine Learning for Big Data						
PHES107	Data Science						
PHES108	Soft Computing						
PHES109	Cloud Computing						
PHES110	Quantum Computing						

Semester 2 coursework

PH-102	Viva Voce Examination	0	0	12			

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

Course Code	**HSMC**	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. Use of non-programmable calculators is allowed.

Course Objectives:

- To formulate a viable research question.
- To distinguish probabilistic from deterministic explanations.
- To analyze 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 Analyze 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:

COs1: Identify and discuss the role and importance of research in the social sciences.

COs2: Identify and discuss the issues and concepts salient to the research process.

COs3: Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.

COs4: Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Text Books:

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

Reference Books:

1. Wayne L. Winston, "Microsoft Excel Data Analysis and Business Modeling", 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	**Digital Video Processing**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- To impart knowledge to the students in the field of Digital Video Processing.

Section	Course Content
Section-A	Basic steps of Video Processing: Analog Video, Digital Video, Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.
Section-B	Motion Estimation: Optical flow, General Methodologies, Pixel Based Motion Estimation, Block-Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Application of 2D motion estimation, Parametric motion models.
Section-C	Optical Flow methods, Motion-compensated filtering, Video processing operations including noise reduction, restoration, super resolution, de-interlacing and video sampling structure conversion, and compression (frame-based and object-based methods), Video quality assessments
Section-D	Video segmentation, motion segmentation, tracking, optimization Topics from latest research papers.

Course Outcomes:

COs1: To understand the need for image transforms different types of image transforms and their properties.
COs2: To understand the rapid advances in Machine vision.
COs3: To learn different techniques employed for the enhancement of images.

TEXTBOOK :

As advised by course instructor

1. Digital Video Processing – M. Tekalp, Prentice Hall International
2. Handbook of image and video processing, Bovik
3. The Essential Guide to Video Processing, Bovik

REFERENCE BOOKS:

1. Video processing and communication – Yao Wang, Joem Ostermann and Yaquin Zhang. 1st Ed., PH int.
2. Digital Video Processing by Tekalp

Name of the Course	**Pattern Recognition**		
Course Code	**PHES102**	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. Use of non-programmable calculators is allowed.

Course Objectives:

- This course deals with pattern recognition which has several important applications. For example, multimedia document recognition (MDR) and automatic medical diagnosis are two such.

Section	Course Content
Section-A	Pattern & Pattern classes, Pattern recognition Design Cycle, Feature Extraction: Feature processing & normalization, Learning (Supervised, Unsupervised, Reinforced). Preliminary concepts and pre-processing phases, coding, normalization, filtering, linear prediction, Feature extraction and representation thresholding, contours, regions, textures, template matching, Hidden Markov Models, Taxonomy of pattern classifiers
Section-B	Data structure for pattern recognition, statistical pattern recognition, clustering Technique and application. Study of pattern classifiers: Supervised and unsupervised.
Section-C	Pattern Classifiers: Statistical: Bayesian theorem, Bayesian classifier: Minimum distance, Maximum likelihood), Naïve Bayes, Linear Discriminant Analysis, k- nearest neighbour (KNN), Artificial Neural Network etc. and Case studies.
Section-D	Performance measurement metrics: Confusion matrix, Accuracy, Precision, Recall, ROC curve, Area Under Curve (AUC), Confidence intervals. Data partitioning (K-fold cross validation, Leave one out , Leave m-out) Clustering techniques and algorithms, Deep learning

Course Outcomes:

COs1: Summarize, analyze, and relate research in the pattern recognition area verbally and in writing. ... Apply pattern recognition techniques to real-world problems such as document analysis and recognition. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

TEXTBOOK:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
2. K. Fukunaga, Statistical pattern Recognition; Academic Press, 2000.
3. Devi V.S.; Murty, M.N., Pattern Recognition: An Introduction, Universities Press, Hyderabad, 2011

REFERENCE BOOKS:

1. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.

Name of the Course	**Computational Aspects of Bioinformatics**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- The aim of this module is to study, learn, and understand the main **concepts** of **advanced operating systems** (parallel processing **systems**, distributed **systems**, real time **systems**, network **operating systems**, and open source **operating systems**); Hardware and software features that support these **systems**.

Section	Course Content
Section-A	Basics Of Bioinformatics Molecular Biology Primer: What Is Life Made Of? What Is the Genetic Material? What Do Genes Do? What Molecule Codes for Genes? How Do Individuals of a Species Differ? How Do Different Species Differ? , Why Bioinformatics? DNA and Chromosome: The structure and function of DNA, Chromosomal DNA and its packaging in the chromatin fiber, DNA replication repair and recombination ,how to cell read to genome: from DNA to protein, RNA: Comparison with DNA, Structure Synthesis,Types of RNA, RNA translation, Protein: Protein structure and function, Protein synthesis: Chemical synthesis, Biosynthesis, Cellular function: Enzymes, Cell signaling and legend binding, Structural protein, Protein disorder, Proteomics Exhaustive Search: Restriction Mapping, Impractical Restriction Mapping Algorithms, A Practical Restriction Mapping Algorithm, Regulatory Motifs in DNA Sequences, Profiles, The Motif Finding Problem, Search Trees, Finding Motifs, Finding a Median String.
Section-B	Gene-Gene Interaction :Sample size requirement method, Matched case control design, The case sibling, Case Parent, Computing methods: ayes

	classifier, Neural Network, Random Forest, Multifactor dimensionally Reduction, Cellular Automata, Symbolic Discriminating Analysis, Protein-Protein Interaction: Methods based on genomic content and structure, Co – Locations, Phylogenetic Profiles, Gene Fusion Software Tools: GENIE, GWGGI, STRING 10.
Section-C	Dynamic Programming Algorithms: The Power of DNA Sequence Comparison, The Change Problem Revisited, The Manhattan Tourist Problem, Edit Distance and Alignments, Longest Common Subsequences, Global Sequence Alignment, Scoring Alignments, Local Sequence Alignment, Alignment with Gap Penalties, Multiple Alignment, Gene Prediction, Statistical Approaches to Gene Prediction, Similarity-Based Approaches to Gene Prediction, Spliced Alignment.
Section-D	Divide-and-Conquer Algorithms: Divide-and-Conquer Approach to Sorting, Space-Efficient Sequence Alignment, Block Alignment and the Four-Russians Speedup, Constructing Alignments in Subquadratic Time. Combinatorial Pattern Matching: Repeat Finding, Hash Tables, Exact Pattern Matching, Keyword Trees, Suffix Trees, Heuristic Similarity Search Algorithms, Approximate Pattern Matching, BLAST: Comparing a Sequence against a Database. Hidden Markov Models: CG-Islands and the "Fair Bet Casino", The Fair Bet Casino and Hidden Markov Models, Decoding Algorithm , HMM Parameter Estimation , Profile HMM Alignment.

Course Outcomes:

COs1: Understanding and development of developing algorithms for solving bioinformatics problems such as mapping DNA, Sequencing DNA, Comparing Sequences, Predicting genes, Finding Signals, Identifying Proteins, Repeat Analysis, DNA Arrays, Genome Rearrangements, Molecular Evolution.

Text Books/Reference Books:

Introduction to bioinformatics Book by Arthur M. Lesk Bioinformatics Sequence and Genome Analysis Book By Arthur David W. Mount Python programming for Biology book By Tim J. Stevens and Wayne Boucher

1. 'TEXTBOOK By NEIL C. JONES AND PAVEL A. PEVZNER, The MIT Press Cambridge.

Name of the Course	**Cognitive Computation**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- Cognitive computing refers to systems that learn at scale, reason with purpose, and interact with humans naturally. The objective is to learn the various recent methods in this field.

Section	Course Content
Section-A	Introduction to Cognitive Systems and computation, Knowledge based AI: Cognitive systems, Different modes of Computing: Turning machine Lambda, Calculus, Hyper Computing, Super Computing, Pan Computing and Interactive Computing.
Section-B	Cognitive Functioning: Learning, Memorizing, Adaptation, Self Origination, Control, Thinking, Reasoning, Decision Making &Judgment.
Section-C	Mental States: Belief Desire Intention (BDI) emotion and feting. Computation of Cognitive Functioning in machines: Robotics, Human-Robotics Interaction, Hepatic.
Section-D	Perception and sensing: Hardware machines of vision and audition with reference to human and machine Cognitive function measurement tools and software.

Course Outcomes:

COs1: Introduction to computational theories of human cognition. We use formal models from artificial intelligence and mathematical psychology to consider fundamental issues in human knowledge representation, inductive reasoning, learning, decision-making and language acquisition.

COs2: What kind of informational structures describe the organization of human

knowledge, and what kinds of inferences do they license? How do humans make choices given time constraints, computational limitations, and external costs imposed by the world? What kinds of innate knowledge (if any) must people have?
Text Books: 1. Vijay Raghavan Venk at Gudivada Venu Govindaraju C.R. Rao 2. Computation and CognitionToward a Foundation for Cognitive Science By Zenon W. Pylyshyn 3. Cognitive Computing: Theory and Applications: Volume 35 (Handbook of Statistics)

Name of the Course	**Augmented Reality and Virtual Reality**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- This course provides students with an opportunity to explore the research issues in Augmented Reality and Virtual Reality (AR &VR).
- It also makes the students know the basic concept and framework of virtual reality.

Section	**Course Content**
Section-A	Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Multiple Models of Input and Output Interface in Virtual Reality: Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices.
Section-B	Visual Computation in Virtual Reality: Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Manus, Object Grasp.
Section-C	Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, Multi Gen, Vir-tools etc. Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.
Section-D	Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization

	techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Course Outcomes:

COs1: Students are able to Has acquired knowledge in **VR** and **AR** technologies in terms of used devices, building of the **virtual** environment and modalities of interaction and modeling.

COs2: Has acquired knowledge in the main application of **VR** and **AR** technologies in medicine and surgery, cultural heritage and games.

TEXT BOOKS:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

REFERENCE Books:

1. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.

Name of the Course	**Machine Learning for Big Data**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- To offer understanding of big data and a look at the dominant software systems and algorithms for coping with Big Data.
- To introduce machine learning and the analysis of large data sets using distributed computation and storage infrastructure.

Section	Course Content
Section-A	Understanding big data landscape, Getting Started with Big Data Analytics, Analyzing Big Data in Context, Getting Value from Predictive Analytics and Big Data
Section-B	Humanizing Big Data Analytics, Publishing Data and Analytics to Cloud Service, evaluating tools and techniques
Section-C	Introduction: Definition, Probability Theory, Basic Algorithm Density Estimation: Limit Theorems, Parzen Window, Estimation, Sampling
Section-D	Optimization: Preliminaries, Unconstrained Smooth Convex Minimization, constraint, stochastic, non-convex optimizations, online learning and boosting. Conditional densities: regression, multiclass classification, CRF, Hidden Markov Models.

Course Outcomes:

COs1: The students learning outcomes are designed to specify what the students will be able to perform after completion of the course.

COs2: Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.

Text Books:

1. Introduction to Machine Learning by Alex Smola and S.V.N. Vishwanathan,Cambridge university press, 2008
2. Big Data analytics for DUMMIES by Michael Wessler, OCP & CISSP, John Wiley & Sons

Reference Books:

1. Machine Learning: A Probabilistic Perspective By Kevin P. Murphy, MIT Press.
2. Foundation of machine learning by By Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar,
3. MIT Press
4. Introduction To Machine Learning by Nils J. Nilsson, Robotics Laboratory

Big Data Now by by O'Reilly Media, Inc. 2013.

Name of the Course	**Data Science**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- Knowledge of Data Science
- Knowledge of Python
- To understand Panda

Section	Course Content
Section-A	Introduction to Data Science - Why Python? - Essential Python libraries - Python Introduction- Features, Identifiers, Reserved words, Indentation, Comments, Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set - Type Conversion- Operators. Decision Making- Looping- Loop Control statement- Math and Random number functions. User defined functions - function arguments & its types.
Section-B	User defined Modules and Packages in Python- Files: File manipulations, File and Directory related methods - Python Exception Handling. OOPs Concepts - Class and Objects, Constructors – Data hiding- Data Abstraction- Inheritance. NumPy Basics: Arrays and Vectorized Computation- The NumPyndarray - Creating ndarrays - Data Types for ndarrays - Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-Sorting Unique and Other Set Logic
Section-C	Introduction to Pandas Data Structures: Series, Data Frame, Essential Functionality: Dropping Entries Indexing, Selection, and Filtering- Function

	Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.
Section-D	Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.

Course Outcomes:

At the end of the course students will able to:

COs1: Have comprehensive knowledge of Data Science and working of Python and Panda as an advanced course.

TEXT BOOKS:

1. Y. Daniel Liang, "Introduction to Programming using Python", Pearson, 2012.
2. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I Python", O'Reilly, 2nd Edition, 2018.
3. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly, 2017.

REFERENCE BOOKS:

1. Wesley J. Chun, "Core Python Programming", Prentice Hall, 2006.

Name of the Course	**Soft Computing**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- The course aims at providing knowledge of soft computing concepts and introducing the idea of neural networks, fuzzy logic and use of genetic algorithms.
- At the end of this course, students should be able to analyze the implementation of neural networks, implementation of genetic algorithms in various Optimization problems and use of Fuzzy Logic.

Section	Course Content
Section-A	Intelligent Agents: Agents Behavior and Environments, Structure of Agents, Planning Problem, Planning with state Space Search, Partial order Planning, GRAPHPLAN, Planning in logic, planning in non-deterministic domains, hierarchical task planning, Multi agent planning, execution.
Section-B	Probabilistic Reasoning Fuzzy Logic: Knowledge representation under uncertainty, Bayesian theorem, Bayesian Networks, Dumpster Shafer theory, Representing vagueness, Fuzzy sets, operation on fuzzy sets, reasoning with fuzzy logic, Fuzzy Automata, Fuzzy Control methods, Fuzzy decision making, inference in temporal models, Hidden Markov Models, Kalman Filters.
Section-C	Neural Networks: Basic concepts, Single layer perception, Multilayer Perception, Supervised and Unsupervised learning – Backpropagation networks - Kohnen's self organizing networks - Hopfield network. Introduction to Artificial Neural Systems - Perceptron - Representation - Linear separability - Learning – Training algorithm -Adaptive networks based Fuzzy interface systems - Classification and Regression Trees - Data clustering algorithms -

	Rule based structure identification - Neuro-Fuzzy controls - Simulated annealing
Section-D	Generic Algorithms: Evolutionary computation. Survival of the Fittest - Fitness Computations - Cross over – Mutation, Reproduction - Rank method - Rank space method.

Course Outcomes:

COs1: Understand **soft computing** techniques and their role in problem solving. Conceptualize and parameterize various problems to be solved through basic **soft computing** techniques.

COs2: Analyze and integrate various **soft computing** techniques in order to solve problems effectively and efficiently.

Text Book:

1. Stuart J.Russel, Norvig: AI: A Modern Approach, Pearson Education, and Latest Edition.
2. Michael Negnevitsky: Artificial Intelligence: A Guide to Intelligent Systems, 2/E, Addison-Wesley.

References:

1. James Freeman A. and David Skapura M: Neural Networks - Algorithms, Applications & Programming Techniques Addison Wesley.
2. Yegnanarayana B: Artificial Neural Networks, Prentice Hall of India Private Ltd., New Delhi.
3. Hagan, M.T., Demuth, Mark Beale: Neural Network Design By Cengage Learning.
4. Goldberg, David E.: Genetic algorithms in search, optimization and machine learning, Latest Edition, Addison Wesley.

Name of the Course	**Cloud Computing**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- To understand the emerging area of "cloud computing" and how it relates to traditional models of computing.
- To impart fundamental concepts in the area of cloud computing.
- To impart knowledge in applications of cloud computing.
- Understanding the systems, protocols and mechanisms to support cloud computing

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.
Section-B	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. Cloud Computing Architecture: Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networking Cloud computing, protocols used, Role of Web services.

Section-C	Trees – Terminology, Representation of Trees, Binary tree ADT, Properties of Binary Trees, Binary Tree, Representations-array and linked representations, Binary Tree traversals, Threaded binary trees, Max Priority Queue ADT-implementation-Max Heap-Definition, Insertion into a Max Heap, Deletion from a Max Heap. Graphs – Introduction, Definition, Terminology, Graph ADT, Graph Representations- Adjacency matrix, Adjacency lists, Graph traversals- DFS and BFS.
Section-D	Searching- Linear Search, Binary Search, Static Hashing-Introduction, hash tables, hash functions, Overflow Handling. Sorting-Insertion Sort, Selection Sort, Radix Sort, Quick sort, Heap Sort, Comparison of Sorting methods. Search Trees-Binary Search Trees, Definition, Operations- Searching, Insertion and Deletion, AVL Trees- Definition and Examples, Insertion into an AVL Tree, B-Trees, Definition, B-Tree of order m, operations-Insertion and Searching, Introduction to Red-Black and Splay Trees(Elementary treatment-only Definitions and Examples). Comparison of Search Trees. Pattern matching algorithm- The Knuth-Morris-Pratt algorithm, Tries (examples only).

Course Outcomes:

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

COs1: Identify the applications of IoT

COs2: Use Raspberry PI platform in designing IoT based applications

COs3: Create real time applications that can be used in domestic and health care applications

COs4: Convert things into smart things.

Text Book:

CloudComputingBible,BarrieSosinsky,Wiley-India,2010

Reference Books:

1. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile,2011.
2. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee-Gillam, Springer, 2012.
3. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L.Krutz, Russell DeanVines, Wiley-India, 2010.

Name of the Course	**Quantum Computing**		
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. Use of non-programmable calculators is allowed.

Course Objectives:

- The objective of this course is to provide the students an introduction to quantum computation.
- Much of the background material related to the algebra of complex vector spaces and quantum mechanics is covered within the course.

Section	Course Content
Section-A	**Introduction to Quantum Computation:** Quantum bits, Bloch sphere representation of a qubit, multiple qubits. **Background Mathematics and Physics:** Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of Quantum mechanics, Measurements in bases other than computational basis.
Section-B	**Quantum Circuits:** single qubit gates, multiple qubit gates, design of quantum circuits. **Quantum Information and Cryptography:** Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem.
Section-C	**Quantum Algorithms:** Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.
Section-D	**Noise and error correction:** Graph states and codes, Quantum error correction, Fault-tolerant computation.

Course Outcomes:

At the end of the course, the student should be able to:

COs1: The course represents a comprehensive survey on the concept of quantum computing with an exposition of qubits, quantum logic gates, quantum algorithms and implementation.

COs2: Starting with the main definitions of the theory of computation, the course mostly deals with the application of the laws of quantum mechanics to quantum computing and quantum algorithms.

Text Books/Reference Books:

S.No.	*Author(s)/Name of Books/Publishers*
1.	Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.
2.	Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.
3.	Pittenger A. O., An Introduction to Quantum Computing Algorithms