Course Description

Science Electives:

Course Title: Data Science **Course Code: 18B14MA541**
L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied the course "Business Analysis Techniques"

Course Objectives:
This course will introduce students to this rapidly growing field and equip them with some of its basic principles and tools as well as its general mindset. Students will learn concepts, techniques and tools they need to deal with various facets of data Science practice, including data collection and integration, exploratory data analysis, predictive modelling, descriptive modelling, data product creation, evaluation, and effective communication.

Learning Outcomes:
At the end of the course students should be able to:

Course Outcome	Description
CO1	Develop relevant programming abilities.
CO2	Demonstrate proficiency with statistical analysis of data.
CO3	Develop the ability to build and assess data-based models.
CO4	Execute statistical analyses with professional statistical software.
CO5	Demonstrate skill in data management.
CO6	apply data science concepts and methods to solve problems in real-world contexts

Course Content:

Unit I: Introductionand Data Pre-processing
Data Science Introduction, Big Data and Data Science, Current landscape of perspectives

Unit II: Data Analysis and Correlations: Basic Concepts and Methods
Populations and samples, Statistical modelling, probability distributions, Regression,fitting a model Dimensionality Reduction: PCA & DWT, Correlation and regression analysis. Chisquare t and F distributions (definitions only) Confidence interval Single mean and difference known and unknown variances.

Unit III: Introduction to machine learning and Cluster Analysis: Basic Concept and Methods
Supervised and unsupervised learning, Training and testing data, over fitting and under fitting. Distance measures :- Manhattan, Chebbychev, Mahalanobis Distance, Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of Clustering, Clustering High-Dimensional Data, Clustering Graph and Network Data

Unit IV: Classification Algorithms
Basic Concepts, Decision Tree Induction, Bayes Classification Methods, Rule-Based Classification, Model Evaluation and Selection, Techniques to Improve Classification Accuracy, Support Vector Machines, Lazy Learners (or Learning from Your Neighbors)

Unit V: Introduction to Web Search and Social Media Analytics

Data Wrangling: APIs and other tools for scrapping the Web Mining Complex Data Types, Other Methodologies of Data, Mining, Data Mining Applications, Data Mining and Society, Data Mining Trends Social Media Analytics is the science of analyzing data to convert information to useful knowledge. This knowledge could help us understand our world better and, in many contexts, enable us to make better decisions.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Text Books:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk fromthe Frontline. O'Reilly. 2014.
2. Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science.

Refernce Books:

1. Jure Leskovek, Anand Rajaraman and Je_rey Ullman. Mining of Massive Datasets. v2.1,
2. Cambridge University Press. 2014.
3. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.
4. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know aboutData Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
5. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition. ISBN 0387952845. 2009.

Title of Course: Science of Web **Course Code: 18B14MA542**
L-T-P Scheme: 3-0-0 **Course Credits: 3**

Prerequisites: Students must have already registered for the course, "Introduction to Computers and Programming".

Objectives:

1. To make students aware of the concepts, vocabulary and procedures associated with Internet, Web Designing & Web Development.

Learning Outcomes: Student shall be able to-

1. Explain different procedures and technologies underlying Web Applications.
2. Analyze and decompose problems associated with risk and management of Web Based Systems.

Course Outcome	Description
CO1	Get **familiar** with process of Web Development.
CO2	Have a good grounding of Web Application Terminologies, Internet tools and languages like HTML5 and CSS, and identify the typical use cases where to **apply** these tools.
CO3	**Analyze** a problem and possess demonstrative skills in using and applying web science to provide solutions.
CO4	**Design and code** the business requirements to come up with a technical solution using different web-based technologies.
CO5	Work as a team on a project.

Course Contents:

Unit-I: Web Basics: Networking Protocols and OSI Model, Internet Working Concepts, Devices and Internet Basics like repeaters, Virtual Networks, Routers, Gateways etc. TCP/IP, IP, UDP, ARP, DNS, Email, FTP, TELNET, HTTP, HTML etc.

Unit-II: Client Side and Server Side Technologies: CSS, JavaScript, CSS & JavaScript Frameworks, AJAX, PHP/MySQL, ASP.NET, Java Web Technologies like Servlets, JSP, JDBC, Beans, Database, Introduction to XML.

Unit-III: Web Security: Principles of Security, Cryptography, Digital Certificates, Digital Signatures, SSL, Online Payments, 3-D Secure Protocol.

Unit-IV: Mobile Applications and Cloud Computing: Embedded Device Programming, Open Handset Alliance and Android, Cloud Computing, Benefits of Cloud Computing and Challenges, Internet of Things.

Unit-V: Miscellaneous: Website Effectiveness: Strategies and Challenges, SEO, XHTML and Web Browser Compatibility Issues.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Text Books

1. Jeffrey Zeldman, “Designing with Web Standards”, O’Reilly Media, third edition, 2001.
2. Kogent Learning Solutions Inc, “Black Book: Web Technologies”, dreamtech, edition, 2013.

References

Janice Reynolds, “The Complete E-Commerce Book”, Focal Press, Second Edition, 2004.

Title of Course: Fuzzy Systems and Applications **Course Code: 18B14MA544**
L-T-P Scheme: 3-0-0 **Course Credits: 3**

Course Objectives

This course aims to develop students' abilities in using some contemporary approaches in solving problems which are fuzzy in nature..

It will enable students to appreciate the advantages and limitations of fuzzy systems and their potential impacts and applications in intelligent control and automation;

Learning Outcomes: Student shall be able to-

1. Explain different procedures and technologies underlying Web Applications.
2. Analyze and decompose problems associated with risk and management of Web Based Systems.

Course Outcome	Description
CO1	Get **familiar** with fuzzy logic control and adaptive fuzzy logic..
CO2	Identify and describe Fuzzy Logic techniques in building intelligent machines.
CO3	Apply Fuzzy Logic models to handle uncertainty and solve engineering problems.
CO4	Recognize the feasibility of applying a Neuro-Fuzzy model for a particular problem.
CO5	Integrate neural network and fuzzy logic to extend the capabilities for efficient and effective problem solving methodologies.

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Course content:

Unit -1

Introduction to classical set theory, fuzzy set theory, crisp and non-crisp sets: representation, capturing uncertainty, examples. Fuzzy Set: Fuzzy membership, graphic interpretation of fuzzy sets, small, prime numbers, universal, finite infinite, empty space,

Unit -2

Fuzzy Operations: inclusion, comparability, equality. Complement, Union, Intersection, Difference. Fuzzy Properties: Related to union – Identity, Idempotence, Associatively, Commutativity. Related to Intersection – Absorption, Indentity, Idempotence, Associatively. Additional properties – Distributivity. Law of excluded middle, law of contradiction, Cartesian product.

Unit -3

Fuzzy Relations – Definition of Fuzzy Relation, examples. Forming Fuzzy Relations – Membership matrix, graphical form, Projections of fuzzy relations- first, second and global, Max-Min and Min-Max compositions.

Unit -4

Fuzzy Systems : Fuzzy system elements : Input vector, Fuzzification, Fuzzy Rule Base, Membership function, Fuzzy Inferencing, Defuzzyfication, Output vector. Statement, Symbols, Tautology, Membership functions from facts, Modus Ponens and Modus Tollens; Fuzzy logic : Proposition, Connectives, Quantifiers.

Unit -5

Fuzzification Examples and applications, Fuzzy Inference Approximate reasoning; Generalized Modus Ponens (GMP); Generalized Modus Tollens (GMT), Fuzzy Rule Based System Example, Defuzzification Centroid method.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Readings

Ross, T. J. (2009). Fuzzy Logic with Engineering Applications: Wiley, will be used as the main text book, however the inputs will be supplemented with information from elsewhere wherever the same is required.

Other References:

1. "Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence" by Kosko, Bart
2. "Neural Networks, Fuzzy Logic, and Genetic Algorithms" by S. Rajasekaran, G.A. Vijayalakshmi Pai, (Prentice-Hall of India Private Ltd.)
3. An Introduction to Fuzzy Logic for Practical Applications by by Kazuo Tanaka
4. Fuzzy Sets and Fuzzy Logic: Theory and Applications by George J. Klir Bo Yu

Title of Course: Introduction to Quantum Computing **Course Code: 18B14PH541**
L-T Scheme: 3-0 **Course Credits: 3**

Objective: The course Introduction to Quantum Computing is specifically designed to offer a pedagogical exposure for the students pursuing undergraduate level studies in computer science and electronics. This newly emerging discipline provides many exciting opportunities for the practitioners of physics and engineering. In the first half of the course we intend to cover some fundamental concepts of quantum computation and quantum information theory. In the second half of the course, we will touch upon advanced topics e.g., quantum algorithms and quantum communication.

Prerequisites: Students taking up this course are expected to be familiar with elementary calculus and matrix analysis. The necessary background in quantum mechanics and mathematical physics will be introduced as we go on in the course.

Learning Outcome:

Course Outcome	Description
CO1	Provides basic ideas and limitations of classical computation. Introduces quantification of information in terms of Shannon's Entropy. Provides fundamental ideas of Quantum Physics and their applicability in computation and information processing.
CO2	Demonstrates theoretical framework of Quantum Computation, Linear Algebra, Dirac's notation, linear operators, tensor product, Hilbert spaces. Enables one to work with Gram- Schmidt orthogonalization process. Introduces ideas of quantum measurement, quantum states, their time-evolution and geometrical representation using Bloch-sphere. Provides examples of manipulation of single qubit states.
CO3	Establishes ideas of the Quantum Model of Computation, enabling one to work with simple quantum circuits and quantum logic gates; involving single and multi-qubit states.
CO4	Provides a comparison of probabilistic and quantum algorithms. Demonstrates quantum algorithms such as Deutsch, Deutsch-Jozsa algorithms, Shor's algorithm, Grover's search algorithm.
CO5	Establishes fundamental ideas of quantum entanglement, entanglement in pure and mixed states, No-Cloning theorem for quantum states. Quantum teleportation and Quantum communication.

Course Contents:

Unit I: Introduction & Overview: A brief historical review of basic ideas of classical computation and its scope and limitations. Basic definitions of quantum logic and quantum information. Basic ideas of classical information theory; measures of information (information content and entropy); Maxwell's demon, classical theory of computation; universal computer; Turing machine; computational complexity; uncomputable functions; shortcomings of classical information theory and necessity of quantum information theory. Stern-Gerlach experiment for illustration and existence of electron spin, basic idea of superposition of states. [10]

Unit II: Theoretical Framework of Quantum Computation: Dirac notation and Hilbert spaces, dual vectors, linear operators. The spectral theorem, functions of operators. Tensor products, Schmidt decomposition theorem. State of a quantum system, time evolution of a closed quantum system, measurement in quantum mechanics. Pure and mixed states, density operator, partial trace, general

quantum operators. Bloch Sphere representation of single qubit states, qubit rotations, single qubit gates. [12]

Unit III: Quantum Model of Computation: The quantum circuit model, single and multiqubit operations, universal sets of quantum gates. Efficiency of approximating unitary transformations, implementing measurements with quantum gates. [10]

Unit IV: Quantum Algorithms: Probabilistic versus quantum algorithms. Phase kickback. The Deutsch and Deutsch-Jozsa algorithms. Quantum phase estimation and quantum Fourier transform, error analysis in arbitrary phase estimation. Finding orders, Shor's algorithm for order estimation. Quantum algorithms based on amplitude amplification, Grover's quantum search algorithm and related topics. [8]

Unit V: Quantum Entanglement & Teleportation: Mathematical and physical conceptions of quantum entanglement, entanglement distillation, entanglement of formation. Entanglement in pure and mixed states. No-Cloning theorem for quantum states. Quantum teleportation and quantum communication. [5]

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Text Books & References:

1. Quantum computing explained, D.M. McMahon
2. Approaching Quantum Computing, D.C. Marinescu and G.M. Marinescu
3. Quantum Computation and Quantum Information, M.A. Nielsen and I.L. Chuang
4. An Introduction to Quantum Computing, P. Kaye, R. Laflamme and M. Mosca
5. Explorations in quantum computing, C.P. Williams and S.H. Clearwater
6. Introduction to quantum computers, G.P. Berman
7. The Physics of Information Technology, N. Gershenfeld
8. Quantum Computing, M. Hirvensalo
9. Quantum computing and communications: an engineering approach, S. Imre, F. Balazs
10. Quantum computing: a short course from theory to experiment, J. Stolze, D. Suter
11. The Principles of Quantum Mechanics, P.A.M. Dirac
12. Modern Quantum Mechanics, J.J. Sakurai
13. Problems and solutions in quantum computing and quantum information, W.H. Steeb, Y. Hardy
14. Mathematical Physics, S. Hassani, Springer Verlag

Title of Course: Nano science **Course Code: 18B14PH542**
L-T Scheme: 3-0 **Course Credits: 3**

Objective: The course aims to provide students an understanding of materials and their properties at the atomic level. The course is focused at imparting the effect of scale and size of materials on the properties of engineering materials. Modern development in the area of nano science and nanotechnology emphasizes the manufacturing and processes for the synthesis of nanostructured materials, which are prime objectives to be addressed in this course.

Learning Outcome:

Course Outcome	Description
CO1	Introduction to the concept of Nanoscience and classification of nanostructured materials
CO2	Basic concept of crystal structure and quantum mechanics
CO3	Size effect and its effect on structural properties of materials.
CO4	Introducing basic concepts of defects, crystal structures, band theory of solids in 1D, 2D and 3D.
CO5	Synthesis and characterization of nanostructured materials.

Course Contents :

Unit I (Introduction and Classification of Nano-structured Materials): Nanoscience and Nanotechnology, Brief History and future scope, Gleiter's classification of nano-structured materials, Classification of nanostructures by dimensionality. Properties of Fullerene, Nanotubes, Graphene. [10]

Unit II (Conceptual Background): Concept of matter waves, Schrodinger wave equation, confinement, particle in a potential box, barrier penetration and tunnelling effects, concept of density of states. [6]

Unit III (Size Effects & Properties of Nano-structured Materials): Concept of characteristic time and length scales of physical phenomena, Definition and types of size effects, extended internal surface, increasing surface energy and tension, Grain boundaries, classical and quantum size effects, size dependent thermal, mechanical, electrical, magnetic and optical properties of nano-structured materials e.g. Reduction of lattice parameters, decrease in melting point, decreasing thermal conductivity, diffusion enhancement, increasing plastic yield strength and 8 hardness, blue shift, broadening of energy bands, phase transitions in ferromagnetic and ferroelectric materials. [14]

Unit IV (Synthesis & Characterisation of Nanostructures): Top-down and Bottom approaches, Vapor – phase synthesis, Liquid phase synthesis, Sol-gel technique, Solid – state phase synthesis, consolidation of nano-powders. X-ray diffraction (XRD), UV- visible, FTIR, TGA, Scanning Electron microscopy (SEM), Transmission electron Microscopy (TEM), Scanning probe microscopy, Scanning tunnelling Microscopy (STM) and Atomic Force microscopy (AFM). [10]

Unit V (Application of Nanotechnology): Applications of Nanostructures for diversified fields of Engineering. [5]

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Text Book

1. Nano Structures & Nano Materials, Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press.
2. Concept of modern Physics by Arthur Beiser, 6 th Edison, McGraw-Hill

References

1. Introduction to Solid State Physics by C.Kittel 7th ed. Wiley
2. Nanoscale Energy Transport and Conversion: A Parallel Treatment of Electrons, Molecules, Phonons, and Photons by Gang Chen, Oxford University Press
3. Nano/Micro scale heat transfer by Zhuomin M. Zhang, Mc Graw-Hill Nanoscience and Technology series
4. Nanoscale materials in chemistry, 2 nd edition, by Kenneth J. Klabunde and Ryan M. Richards, John Wiley & Sons.

Course Description

Title of Course: Materials Science and Applications **Course Code: 18B14PH543**
L-T Scheme: 3-0 **Course Credits: 3**

Objective: Materials are the building blocks for almost all the technologies associated with electronic gadgets, electrical components, communication systems, signal processing, storing of information, hardware components and their related accessories. Therefore, search for new materials and study of their properties, useful for electronics, electrical and computer technology has become an area of current interest to the scientists and technologists. The present course aims at giving the students a basic knowledge necessary for understanding electric, magnetic, semiconducting, polymeric, solar and superconducting materials used in engineering applications.

Learning Outcome:

Course Outcome	Description
CO1	Provides basic ideas about the crystal structure, lattice planes and unit cells for the understanding of various physical, electrical and optical properties of solids. Also, to analyse the different crystal structure using the X-ray diffraction technique.
CO2	To understand different polarisation mechanisms related to dielectric materials, which is useful for understanding the mechanism of capacitors and their applications in devices.
CO3	Establishes ideas of magnetic hysteresis in different ferromagnetic materials for their application in magnetic memories, hard drives etc. The topics are significant to understand their soft and hard magnetic behaviour on basis of their magnetic structure and type of materials.
CO4	Provides basic knowledge about the components and working of the battery and other storage devices. Also, these topics explain the basics of solar cells to be used in solar panels and other device applications.
CO5	It gives understanding about the critical temperature and critical magnetic field of the superconductors. Provides explanation of superconductors and HTSC using the BCS theory. It explains how these materials are applicable in Maglev and Squid devices.

Course Contents:

Unit I (Elementary Crystallography): Introduction to crystallography, Lattice translation vectors, Basis and Crystal structure, Symmetry operations, Primitive Lattice cell, Two-dimensional lattice types, systems, Number of lattices, Point groups, Three-dimensional lattice types, Systems, Number of Lattices, Points groups and space groups. Indexing system for crystal planes, Miller indices, Simple crystal structures, NaCl, hcp, diamond structure. 10 X-ray diffraction and Bragg's law; Determination of Crystal structure using Bragg's diffractometer. [10]

Unit II (Dielectric Materials): Polarisation mechanism & Dielectric Constant, Sources of polarizability, Behaviour of polarisation under alternating field, Applications of Dielectric Materials in capacitor, Different types of capacitor, Charging-discharging mechanism of capacitor, Energy stored in capacitor, Design of capacitor banks for specific requirements, Piezo motor and transformer, ferro memory cell. [10]

Unit III (Magnetic Materials): Concept of magnetism, Classification – dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Concepts of electromagnetic induction, application of magnetic materials for motors, transformers, generators and magnetic storage devices. [10]

Unit IV (Materials for Energy Storage & Conversion Devices): Different types of energy storage devices, concept of battery, choice of electrode and electrolyte material for rechargeable battery. Concepts of p-n junction, Solar cell, Applications of solar cells in making solar panels. [10]

Unit V (Superconducting Materials:): Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; BCS Theory, High temperature Superconductors and their Applications. [5]

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Text Books

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
3. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
4. Solid State Physics by S. O. Pillai.