Learning Outcomes based Curriculum Framework (LOCF)

FOR

MASTER OF TECHNOLOGY

(COMPUTER SCIENCE)

M.TECH. (CS)

(W. E. F. 2020-21)

Based on

AICTE Model Curriculum
for Postgraduate Degree Courses

DEPARTMENT OF COMPUTER SCIENCE & I.T.
MAULANA AZAD NATIONAL URDU UNIVERSITY
2020

Program Summary

Course Type	Abbreviation	Credits
Program Core	PC	16
Program Elective	PE	20
Research Methodology & IPR	RMIPR	2
Generic Elective	GE	8
Laboratory	LAB	8
Mini Project with Seminar	MPS	2
Dissertation	DISS	24
Total Credits:		**80**

Semester – I

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS111PCT	Advanced Algorithm	PC	30	70	100	4-0-0	4
MTCS112PCT	Advanced Computer Architecture	PC	30	70	100	4-0-0	4
MTCS111RMT	Research Methodology & IPR	RMIPR	15	35	50	2-0-0	2
MTCS11XPET	Program Elective-1	PE	30	70	100	4-0-0	4
MTCS12XPET	Program Elective-2	PE	30	70	100	4-0-0	4
PGCS13XGET	Generic Elective-1	AC	30	70	100	4-0-0	4
MTCS160PCP	Lab– I Advanced Algorithm Lab	LAB	50	50	100	0-0-4	2
MTCS16XPEP	Lab – II (Based on Elective-I)	LAB	50	50	100	0-0-4	2
Total					**800**	**22-0-8**	**26**

Semester – II

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS211PCT	Machine Learning	PC	30	70	100	4-0-0	4
MTCS212PCT	Internet of Things	PC	30	70	100	4-0-0	4
MTCS21XPET	Program Elective-3	PE	30	70	100	4-0-0	4
MTCS22XPET	Program Elective -4	PE	30	70	100	4-0-0	4
PGCS23XGET	Generic Elective-2	AC	30	70	100	4-0-0	4
MTCS260PCP	Lab – III-ML Lab	LAB	50	50	100	0-0-4	2
MTCS261PCP	Lab – IV -IoT Lab	LAB	50	50	100	0-0-4	2
MTCS270PCP	Mini Project with Seminar*	MPS	50	50	100	0-0-4	2
Total					**800**	**20-0-12**	**26**

***Students are encouraged to go to Industrial Training/Internship for at least 2-3 months during semester break. They need to make a prototype model in the allotted areas on the recommendations of the supervisor.

Semester – III

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS31XPET	Program Elective -5	PE	30	70	100	4-0-0	4
MTCS370PCP	Dissertation-I	DISS	210	490	700	0-0-20	10
Total					**800**	**4-0-20**	**14**

Semester – IV

Course Code	Course Title	Course Type	Marks			L-T-P	Credits
			Internal Assessment	Semester Exam	Total		
MTCS470PCP	Dissertation-II	DISS	240	560	800	0-0-28	14
Total					**800**	**0-0-28**	**80**

L-T-P stands for number of contact hours as Lecture-Tutorial-Practical in a week.

PROGRAM ELECTIVES (PE) & GENERIC ELECTIVES (GE)

Semester – 1st			
Course Code	**Course Title**	**Course Code**	**Course Title**
Program Elective – I with Lab		**Program Elective – II**	
MTCS111PET	Advanced Network Security	MTCS121PET	Intelligent Systems
MTCS112PET	Distributed Database	MTCS122PET	Augmented & Virtual Reality
MTCS113PET	Data Science	MTCS123PET	Soft Computing
MTCS114PET	Semantics Web	MTCS124PET	Digital Forensics
Program Elective – I Lab			
MTCS160PEP	Advanced Network Security Lab		
MTCS161PEP	Distributed Database Lab		
MTCS162PEP	Data Science Lab		
MTCS163PEP	Semantics Web Lab		
Generic Elective-1			
PGCS131GET	English for Research Paper Writing		
PGCS132GET	Disaster Management		
PGCS133GET	Sanskrit for Technical Knowledge		
PGCS134GET	Value Education		

Semester – 2nd			
Program Elective – III		**Program Elective – IV**	
MTCS211PET	Blockchain Technology	MTCS221PET	Advanced Operating System
MTCS212PET	Compilers for High Performance Computing	MTCS222PET	Digital Image Processing
MTCS213PET	Distributed Computing	MTCS223PET	Advanced Wireless & Mobile Networks
MTCS214PET	Natural Language Processing	MTCS224PET	Mobile Applications & Services
MTCS215PET	Quantum Computing	MTCS225PET	Graphics Processing Unit Computing
Generic Elective-2			
PGCS231GET	Constitution of India		
PGCS232GET	Pedagogy Studies		
PGCS233GET	Stress Management by Yoga		
PGCS234GET	Personality Development through Life Enlightenment Skills		

Semester-3rd

Program Elective – V	
MTCS311PET	Deep Learning
MTCS312PET	Secure Software Design & Enterprise Computing
MTCS313PET	Wireless Access Technologies
MTCS314PET	Data Preparation & Analysis
MTCS315PET	Optimization Techniques

Semester-1

Course Code	Course Title	Lecture			
MTCS111PCT	**Advanced Algorithm**	**L**	**T**	**P**	**Semester:** I
Version:	**Date of Approval:**	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:

1. The course is intended to provide the foundations of the practical implementation and usage of Algorithms.
2. Students evolve into a competent programmer capable of designing and analyzing implementations of algorithms and data structures for different kinds of problems.
3. To expose the student to the algorithm analysis techniques and to the classification of problems into complexity classes like P and NP.

Course Outcomes:

By the end of the course, the students will be able to :

1. design and analyze programming problem statements.
2. understand the necessary mathematical abstraction to solve problems.
3. come up with analysis of efficiency and proofs of correctness.
4. comprehend and select algorithm design approaches in a problem specific manner.

Detailed Contents:

Unit: 1	Introduction to algorithm, Growth of functions, Master's Theorem, Sorting: Quick Sort, Heap Sort, Shaker Sort, and Counting Sort.
Unit: 2	Greedy Method: Minimum Spanning Tree-Prim's Algorithm, Tarjan's Algorithm Introduction to Dynamic programming, principal of optimality, Single Source Shortest Path-Bellman-Ford Algorithm, All Pairs Shortest Paths Algorithm-Johnson's Algorithm, Longest Common Sequence (LCS)
Unit: 3	String Matching: Introduction to String Matching, application of string matching, Naive algorithm, Rabin Karp algorithm, Knuth Morris-Pratt algorithm, Boyer-Moore Algorithm.
Unit: 4	NP-Hard and NP-Complete problems: Basic Concepts, Non Deterministic Algorithms, NP - Hard and NP-Complete Classes, Cook's theorem. Randomized Algorithms
Unit: 5	Introduction to parallel algorithm. Parallel Algorithm- Analysis, models, Parallel Random Access Machines (PRAM), Parallel Algorithm Structure, Parallel Algorithms for Sorting, Searching and Merging.

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	Algorithms, Coreman, Rivest, Lisserson, PHI, Third Edition.
2	Design and Analysis of Algorithms, Manas Ranjan Kabat, PHI.

Reference Books:

1	Design and Analysis of Algorithms, R. Panneerselvam, PHI.
2	Parallel Algorithms, Henri Casanova, Arnaud Legrand, Yves Robert, CRC Press.

Course Code	Course Title	Lecture			
MTCS160PCP	Advanced Algorithm Lab	**L**	**T**	**P**	**Semester:** I
Version:	**Date of Approval:**	0	0	4	

Scheme of Instruction			**Scheme of Examination**		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

1. To practice with programming skill and improve the programming logic.
2. To understand the complexity of algorithms.
3. To develop skills to apply appropriate data structures and algorithms in problem solving
4. Students evolve into a competent programmer capable of designing and analyzing implementations of algorithms and data structures for different kinds of problems.

Course Outcomes:

On successful completion of this course students will be able to:

1. describe concepts of data structure and algorithms with respect to practical aspect.
2. write the code for a large program after overcoming the time and space complexity.
3. write the programs that use arrays, records, linked structures, stacks, queues, trees, and graphs.
4. compare alternative implementations of data structures with respect to performance.
5. choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem.

Detailed Contents:

i. Sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n > 5000 and record the time taken to sort. Plot a graph of the time taken versus n on graph sheet. The elements can be read from a file or can be generated using the random number generator. Demonstrate using C/C++/Java/Python how the divide and-conquer method works along with its time complexity analysis: worst case, average case and best case.

ii. Write the Program to implement the following Sorting Algorithms:
   i. Heap Sort
   ii. Shaker Sort
   iii. Counting Sort

iii. Write the program to implement the Minimum Spanning Tree:
   i. Prim's Algorithm
   ii. Tarjan's Algorithm

iv. Write a program to implement the Bellman-Ford Algorithm

v. Write a program to implement the TSP problem.

vi. Write a program to implement the Longest Common Sequence (LCS) problem.

Write the Program to implement the following Pattern Matching Algorithms:
   i. Naive algorithm
   ii. Rabin Karp algorithm
   iii. Knuth Morris-Pratt algorithm
   iv. Boyer-Moore Algorithm

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	The Algorithm Design Manual by Steve S. Skiena, Springer.
2	https://ds1-iiith.vlabs.ac.in/data-structures-1/ https://ds2-iiith.vlabs.ac.in/data-structures-2/

Reference Books:

1	Algorithms: Design and Analysis, Harsh Bhasin, Oxford Publication.
2	The Design and Analysis of Algorithms, Annay Levitin, Pearson.

Course Code	Course Title	Lecture			Semester: I
MTCS112PCT	Advanced Computer Architecture	L	T	P	
Version:	Date of Approval:	3	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.

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	Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing" McGraw-Hill international Edition.

Reference Books:

1	Kai Hwang, "Advanced Computer Architecture", Tata McGraw-Hill
2	El-Rewini, H., & Abd-El-Barr, M. (2005). Advanced computer architecture and parallel processing (Vol. 42). John Wiley & Sons.

Course Code	Course Title	Lecture			Semester: I
MTCS111PET	Advanced Network Security (Elective-I)	L	T	P	
Version:	Date of Approval:	3	0	0	

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

Course Objectives:

1. To understand the concept of security and privacy.
2. To understand the concept of Public and Private key cryptography.
3. To study about message authentication and hash functions
4. To understand various protocols for network security to protect against the threats in the networks.

Course Outcomes:

On successful completion of this course students will be able to:

1. Provide security of the data over the network.
2. Implement various networking protocols.
3. Protect any network from the threats in the world.
4. Do research in the emerging areas of cryptography and network security.

Detailed Contents:

Unit: 1	Introduction to the concepts of Security: The need for security, security approaches, principles of security, modular arithmetic, prime numbers, relative prime numbers, Euler's function, Symmetric Cryptography: Overview of symmetric cryptography, Algorithm types and Modes, International Data Encryption, Algorithm (IDEA), Advanced Encryption Standard (AES)
Unit: 2	Asymmetric Cryptography: Overview of asymmetric cryptography, Rabin algorithm, ElGamal Algorithm, Knapsack Algorithm, Elliptic Curve Cryptography.
Unit: 3	Identity Based Cryptography: Introduction, Boneh-Franklin IBE (BF-IBE), Sakai-Kasahara IBE (SK-IBE), Boneh-Boyen IBE, (BB-IBE)
Unit: 4	Public Key Infrastructure: Digital Certificates, Key Management. Hash Functions, Digital Signature, Message Integrity, Message Authentication, Entity Authentication
Unit: 5	Security at the Application Layer: Email, PGP. Security at the Transport Layer: SSL and TLS. Security at the Network Layer: IPSec. System Security: Malicious Programs, IDS, Firewalls.

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, Behrouz A. Forouzan and Debdeep Mukhopadhyay, McGraw Hill.
2. Introduction to Modern Cryptography, Jonathan Katz and Yehuda Lindell, CRC Press.

Reference Books:

1. Understanding Cryptography, Christof Paar and Jan Pelzl, Springer.
2. Cryptography and Information Security, V K Pachghare, PHI.

Course Code	Course Title	Lecture			Semester: I
		L	T	P	
MTCS161PEP	Advanced Network Security Lab	0	0	4	
Version:	Date of Approval:				

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

1. To understand the defend and protect the network infrastructure, architecture, protocols and applications in order to deliver secured protocols, applications, services and data.
2. Train the students to develop 'hands-on' skills on using tools and testbeds in order to design network and security experiments/simulations.
3. Prepare the students to perform critical thinking, idea generation and implementation, and integration with existing systems when solving real research problems.

Course Outcomes:

A student passing this course should be able to:

1. Demonstrate the ability to understand and synthesize the principles of network security architectures and security frameworks and models;
2. Data integrity, Authentication, Digital Signatures.
3. capable of analysing, designing and managing the requirements of a secure network architecture based on risk analysis and operational requirements in accordance with regulations and standards.
4. Various network security applications, IPSec, Firewall, IDS, Web security, Email security, and Malicious software etc.

Detailed Contents:

1. Write a Program to implement International Data Encryption Algorithm (IDEA).
2. Write a Program to implement Advanced Encryption Standard (AES) Algorithm.
3. Write a Program to implement Rabin Algorithm.
4. Write a Program to implement ElGamal Algorithm
5. Write a Program to implement Knapsack Algorithm.
6. Write a Program to implement Elliptic Curve Cryptography (ECC).
7. Write a Program to implement Digital Signature.
8. Write the program to implement the ID based cryptography algorithms:
   i. Boneh-Franklin IBE (BF-IBE)
   ii. Sakai-Kasahara IBE (SK-IBE)
   iii. Boneh-Boyen IBE, (BB-IBE)
9. Study the web server's code, and find examples of code vulnerable to memory corruption through a buffer overflow. Write down a description of each vulnerability in the file /home/httpd/lab/bugs.txt; use the format described in that file. For each vulnerability, describe the buffer which may overflow, how you would structure the input to the web server (i.e., the HTTP request) to overflow the buffer, and whether the vulnerability can be prevented using stack canaries. Locate at least 5 different vulnerabilities.

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	Practical Cryptography in Python, James Nielson and Christopher K. Monson, Apress Publication.
2	Applied Cryptography: Protocols, Algorithms and Source Code in C, Bruce Schneier, Wiley.

Reference Books:

1	Practical Cryptography for Developers, Svetlin Nakov, https://cryptobook.nakov.com/ (This book is freely available.)
2	Practical Cryptography: Algorithms and Implementations Using C++, Saiful Azad and Al-Sakib Khan Pathan, CRC Press. Source Code: https://sites.google.com/site/spathansite/praccrypt
3	Virtual Lab: http://cse29-iiith.vlabs.ac.in/Introduction.html

MTCS112PET				Distributed Database (Elective-1)	L	T	P	Semester-I
Date of Approval:					4	0	4	
Version:					**Scheme of Examination**			
Scheme of Instruction	:	60 Hrs.		Maximum Score	:	100		
Periods/ Week	:	4		Internal Evaluation	:	30		
Credits	:	4+2		End Semester	:	70		
Instruction Mode	:	Lecture		Exam Duration	:	3 Hrs.		

Course Objectives:

1. To enhance the previous knowledge of database systems by deepening the understanding of the theoretical and practical aspects of the database technologies and showing the need for distributed database technology to tackle deficiencies of the centralized database systems.
2. To expose active and emerging research issues in distributed database systems and application development.
3. To apply theory to practice by building and delivering a distributed database query engine, subject to remote Web service calls.

Course Outcomes:

4. Explain the techniques used for data fragmentation, replication, and allocation during the distributed database design process.
5. Evaluate simple strategies for executing a distributed query to select the strategy that minimizes the amount of data transfer.
6. Describe distributed concurrency control based on the distinguished copy techniques and the voting methods

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 serializablity 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.

Text Books:

1	Silberschatz, corth and Sudershan, Database System Concept, McGraw Hill.
2	Garcia-Molina, Ullman,Widom,' Database System Implementation' Pearson Education

Reference Books:

1	Ceei and Pelagatti,'Distributed Database', TMH.

Course Code	Course Title	Lecture			Semester: I
		L	T	P	
MTCS113PET	Data Science (Elective-2)	3	0	0	
Version:	Date of Approval:				

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:

1. Provide with the knowledge and expertise to become a proficient data scientist.
2. Demonstrate an understanding of statistics and machine learning concepts that are vital for data science
3. Produce Python code to statistically analyse a dataset
4. Critically evaluate data visualisations based on their design and use for communicating stories from data

Course Outcomes:

On completion of the course the student should be able to

1. Explain how data is collected, managed and stored for data science
2. Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists
3. Implement data collection and management scripts

Detailed Contents:

Unit: 1	Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications
Unit: 2	Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources
Unit: 3	Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.
Unit: 4	Data visualization: Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.
Unit: 5	Applications of Data Science, Technologies for visualization, Bokeh (Python), Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

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	Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.
2	Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Reference Books:

1	Field Cady, The Data Science Handbook, Wiley
2	Jake VanderPlas, Python Data Science Handbook: Essential Tools for working with Data, OReily

Course Code	Course Title	Lecture			
MTCS163PEP	Data Science Lab	**L**	**T**	**P**	**Semester:** II
Version:	**Date of Approval:**	0	0	4	

Scheme of Instruction			**Scheme of Examination**		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

4. To learn the essential concepts of Python programming
5. To gain in-depth knowledge of data analytics
6. To perform data visualization, web scraping, and natural language processing.

Course Outcomes:

A student passing this course should be able to:

1. Understand the essential concepts of Python programming such as datatypes, tuples, lists, dicts, basic operators, and functions
2. Perform high-level mathematical computations using the NumPy and SciPy packages and their large library of mathematical functions
3. Perform data analysis and manipulation using data structures and tools provided in the Pandas package
4. Use the Scikit-Learn package for natural language processing and matplotlib library of Python for data visualization

Detailed Contents:

1. Evaluate the datasets containing GDPs of different countries
2. Evaluate the datasets of Summer Olympics, 2012
3. Use SciPy to solve a linear algebra problem
4. Use SciPy to define 20 random variables for random values
5. Analyze the any dataset using Pandas
6. Analyze the dataset in csv format
7. Evaluate a dataset to find the features or media channels used by a firm and sales figures for each channel
8. Analyze a dataset to find the features and response label of it
9. Analyze a given spam collection dataset
10. Analyze the sentiment dataset using NLP
11. Analyze the “auto mpg data” and draw a pairplot using seaborn library for mpg, weight, and origin
12. Draw a pie chart to visualize a dataset
13. Scrape the any website page to perform some tasks
14. Scrape the any website page to perform some tasks
15. Using Hadoop Streaming for Calculating Word Count
16. Using PySpark to Determine Word Count

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	Jake VanderPlas, Python Data Science Handbook: Essential Tools for working with Data, OReily
2	Field Cady, The Data Science Handbook, Wiley

Reference Books:

1	Cathy O’Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O’Reilly.
2	Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Course Code	Course Title	Lecture			Semester-I
MTCS114PET	Semantic Web (Elective-I)	L	T	P	
Version:	Date of Approval:	4	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4+2	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

1. To Introduce Semantic Web Vision
2. Understanding about XML,RDF,RDFS,OWL
3. Querying Ontology
4. Ontology Reasoning
5. Migration from Document to Data Web

Course Outcomes:

1. Understand the semantic web Vision and technologies
2. Understand about ontology
3. Understanding about Data Web

Unit: 1	Foundation of Semantic Web Technologies, Introduction Current web vs Semantic Web, Semantic Web Technologies, A layered approach Descriptive Logic, Introduction, Definition of the basic formalism, Reasoning algorithms, Language extensions
Unit: 2	Structured Web Documents in XML, Introduction, XML, Structuring, Namespaces, Addressing and querying XML document, Processing
Unit: 3	Describing Web Resources: RDF , Introduction, RDF: Basic Ideas , RDF: XML-Based Syntax, RDF serialization , RDF Schema: Basic Ideas, RDF Schema: The Language, RDF and RDF Schema in RDF Schema
Unit: 4	Web Ontology Language: OWL Introduction, OWL and RDF/RDFS, Three Sublanguages of OWL, Description of the OWL Language, Layering of OWL, Examples, OWL in OWL
Unit: 5	SPARQL-SPARQL simple Graph Patterns, Complex Graph Patterns, Group Patterns, Queries with Data Values, Filters, OWL Formal Semantics

Text Books:

1	A Semantic Web Primer by Grigoris Antoniou Frank van Harmelen, The MIT Press Cambridge
2	Linked Data : Evolving the Web into a Global Data space by Tom Heath, Christian Bizer , Morgan & Claypool publication Basic Description Logic by Franz Baader, Warner Nutt

Reference Books:

1	Foundation of Semantic Web Technologies, Pascal Hitzler, Markus and Sebastian
2	Linked Data : Evolving the Web into a Global Data space by Tom Heath, Christian Bizer , Morgan & Claypool publication Basic Description Logic by Franz Baader, Warner Nutt

Course Code	Course Title	Lecture			Semester: I
MTCS121PET	Intelligent Systems (Elective-2)	L	T	P	
Version:	Date of Approval:	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 aim of the course is to introduce to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach. It explores the essential theory behind methodologies for developing systems that demonstrate intelligent behavior including dealing with uncertainty, learning from experience and following problem solving strategies found in nature.

Course Outcomes:

At the end of the course student will be able to:
Able to Demonstrate knowledge of the fundamental principles of intelligent systems and would be able to analyze and compare the relative merits of a variety of AI problem solving techniques.

Detailed Contents:

Unit: 1	Biological foundations to intelligent systems I: Artificial neural networks, Back propagation networks, Radial basis function networks, and recurrent networks.
Unit: 2	Biological foundations to intelligent systems II: Fuzzy logic, knowledge Representation and inference mechanism, genetic algorithm, and fuzzy neural networks.
Unit: 3	Search Methods Basic concepts of graph and tree search. Three simple search methods: breadth-first search, depth-first search, iterative deepening search. Heuristic search methods: best-first search, admissible evaluation functions, hill-climbing search. Optimization and search such as stochastic annealing and genetic algorithm.
Unit: 4	Knowledge representation and logical inference Issues in knowledge representation. Structured representation, such as frames, and scripts, semantic networks and conceptual graphs. Formal logic and logical inference. Knowledge-based systems structures, its basic components. Ideas of Blackboard architectures.
Unit: 5	Reasoning under uncertainty and Learning Techniques on uncertainty reasoning such as Bayesian reasoning, Certainty factors and Dempster-Shafer Theory of Evidential reasoning, A study of different learning and evolutionary algorithms, such as statistical learning and induction 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	Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.
2	Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd Edition.

Reference Books:

1	Laurene Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Prentice Hall, 1993
2	Anderson-An introduction to Artificial Neural Networks‖, Prentice Hall.

Course Code	Course Title	Lecture			
MTCS122PET	Augmented & Virtual Reality –(Elective-I)	L	T	P	Semester: I
Version:	Date of Approval:	4	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4+2	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

2. To understand the basic concept and framework of virtual reality.
3. To understand the elements, architecture, input and output devices of virtual and augmented reality systems.
4. To explore the research issues in Augmented Reality and Virtual Reality (AR &VR).

Course Outcomes:

5. Can Able to explore the research issues in Augmented Reality and Virtual Reality (AR&VR).
6. Able to describe the main application of VR and AR technologies in various area like education games etc..
7. Able to analyse the role and importance of VR &AR in the modern world.

Detailed Contents:

Unit: 1	Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality.
Unit: 2	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.
Unit: 3	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.
Unit: 4	Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Manus, Object Grasp. Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools 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.
Unit: 5	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.

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	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.
2	Gerard Jounghyun Kim, Designing Virtual Systems: The Structured Approach, 2005.

Course Code	Course Title	Lecture			Semester:
MTCS123PET	Soft Computing (Elective-2)	L	T	P	I
Version:	Date of Approval:	3	1	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:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
2. To implement soft computing-based solutions for real-world problems.
3. To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
4. To provide student hand-on experience on MATLAB to implement various strategies.

Course Outcomes:

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

1. Identify and describe soft computing techniques and their roles in building intelligent machines
2. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
3. Apply genetic algorithms to combinatorial optimization problems.
4. Evaluate and compare solutions by various soft computing approaches for a given problem.

Detailed Contents:

Unit: 1	INTRODUCTION TO SOFT COMPUTING AND NEURALNETWORKS: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics
Unit: 2	FUZZY LOGIC: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.
Unit: 3	NEURAL NETWORKS: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks
Unit: 4	GENETIC ALGORITHMS: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition.
Unit: 5	Recent Trends in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.

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	Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro: Fuzzy and Soft Computing, Prentice: Hall of India, 2003.
2	George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.

Reference Books:

1	Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.
2	Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd Edition.

Course Code	Course Title	Lecture			Semester: I
MTCS124PET	Digital Forensics (Elective-2)	L	T	P	
Version:	Date of Approval:	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:

1. Have an introduction into the process of Digital Forensics.
2. Understand the Environment of forensics & learn process of collecting evidences.

Course Outcomes:

1. Identify the need for cybercrime investigation.
2. Understand the hardware and software components responsible for seeking evidence.
3. Have knowledge on the techniques used for collecting evidences.
4. Analyze the evidence through suitable tools.
5. Examine other sources of evidences.

Detailed Contents:

Unit: 1	INTRODUCTION: Introduction to Forensic Science, Digital Forensics, Digital Evidence. Digital Forensics Process: – Identification, Collection, Examination, Analysis, Presentation Phases. Cyber Crime Law- International Legal Framework of Cybercrime Law, Digital Crime, Investigation Methods for Collecting Digital Evidence.
Unit: 2	FORENSICS ENVIRONMENTS: Hardware and Software Environments – Storage Devices, Operating System, File Systems, and Metadata, Locating evidence in file systems-Password security, Encryption, and Hidden files. Case study – linking the evidence to the user, Data Analysis using forensics tool ILookIX.
Unit: 3	COLLECTING EVIDENCES: Use of Digital Evidence, File Metadata and Correlation with Other Evidence, Technical Complexities of Digital Evidence. Data carving, Date and time problems, Physical Acquisition and Safekeeping of Digital Evidence. Forensic Imaging Processes. Case Study – IXImager, Understanding .ASB Container.
Unit: 4	ANALYZING DIGITAL EVIDENCE : Selecting and Analyzing Digital Evidence - Locating digital evidence, Categorizing files, Eliminating superfluous files, Validating the Evidence . Case study – illustrating the recovery of deleted evidence held in volume shadows.
Unit: 5	OTHER SOURCES OF EVIDENCES : Windows and Other Operating Systems as Sources of Evidence, Examining Browsers, E-mails, Messaging Systems, and Mobile Phones, Internet and Cloud Challenges in Digital Forensics. Digital forensic Report writing & Presentation, Validation of Report.

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	Richard Boddington, Practical Digital Forensics, PACKT publishing, First Edition, 2016 ANDRÉ ÅRNES.
2	Practical Mobile Forensics, PACKT publishing , 2014 Satish Bommisetty, Rohit Tamma, Heather Mahalik

Reference Books:

1	"Guide to Computer Forensics and Investigations" 4e, Nelson, Phillips Enfinger, Steuart, Cengage Learning.
2	Android Forensics Investigation, Analysis, and Mobile Security for Google Android, Andrew Hoog, John McCash.

MTCS111RMT	**Research Methodology and IPR**	**L**	**T**	**P**	
Version:	**Date of Approval:**	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.

Prerequisite(s): It is expected that the students have done any programming language course

Course Objectives:

1. Understanding research problem and scientific approaches applied for
2. Analyse research related information and follow the research ethics
3. Understanding the need of Intellectual Property Right to be promoted among students in general & engineering in particular.

Course Outcomes:

After successful completion of the course the Students will be able to:

1. Design and formulate research problem scientifically and identify the research objectives
2. Apply the systematic approach to achieve research objectives with value and ethics in research publications
3. Implementing the patent rights for the developed research, Copyright & IPR

Detailed Contents:

Unit: 1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Approaches of investigation of solutions for research problem.
Unit: 2	Data Analysis and Statistical Techniques Data and their analyses, quantitative methods and techniques, Measure of central tendency, measures of variation, frequency distribution, analysis of variance methods, identifying the distribution with data, parameter estimation, Goodness-of-Fit tests-Chi-Square test, Correlation analysis, Regression analysis, time series and forecasting. test of hypothesis
Unit: 3	Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee
Unit: 4	Patents and Copyright: Process of Patenting and Development: International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

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	Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2	Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

Reference Books

1	Ranjit Kumar,2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

Course Code	Course Title	Lecture			Semester: I
		L	T	P	
PGCS131GET	**ENGLISH FOR RESEARCH PAPER WRITING (Generic Elective-I)**				
Version:	**Date of Approval:**	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:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

Course Outcomes:

1. Understand the English for Writing Research Papers, Thesis.

Detailed Contents:	
Unit: 1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness
Unit: 2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
Unit: 3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.
Unit: 4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,
Unit: 5	Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

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	Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2	Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
Reference Books	
1	Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
2	Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Code	Course Title	Lecture			Semester: I
PGCS132GET	**DISASTER MANAGEMENT (Generic Elective-I)**	**L**	**T**	**P**	
Version:	**Date of Approval:**	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:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Course Outcomes:

1.------

Detailed Contents:

Unit: 1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.
Unit: 2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Diseases And Epidemics, War And Conflicts.
Unit: 3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post Disaster Diseases And Epidemics
Unit: 4	Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.
Unit: 5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. **Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

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	Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of
2	Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication

Reference Books

1	R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New

Course Code	Course Title	Lecture			Semester: I
PGCS133GET	**Sanskrit for Technical Knowledge (Generic Elective-1)**	**L**	**T**	**P**	
Version:	**Date of Approval:**	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:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes:

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

Detailed Contents:	
Unit: 1	Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences
Unit: 2	Order, Introduction of roots
Unit: 3	Technical information about Sanskrit Literature
Unit: 4	Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics
Unit: 5	Literature of Sanskrit and writing

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. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

Reference Books

1. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Code	Course Title	Lecture			Semester: I
PGCS134GET	**VALUE EDUCATION (Generic Elective-1)**	**L**	**T**	**P**	
Version:	**Date of Approval:**	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:

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Course Outcomes:

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

Detailed Contents:

Unit: 1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments
Unit: 2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline
Unit: 3	Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature
Unit: 4	Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility.
Unit: 5	Role of Women. All religions and same message. Mind your Mind, Self-control Honesty, Studying effectively

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	Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Semester-2

Course Code	Course Title	Lecture			
MTCS211PCT	**Machine Learning**	**L**	**T**	**P**	**Semester:** II
Version:	**Date of Approval:**	3	1	0	

Scheme of Instruction			**Scheme of Examination**		
Total Duration	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

PRE-REQUISITES: Knowledge of basic data science algorithms

Course Objectives:

1. The course aims to learn about the purpose of Machine Learning and where it applies to the real worlds
2. To understand a range of machine learning algorithms along with their strengths and weaknesses
3. To learn methodology and tools to apply machine learning algorithms to real data and evaluate their performance.

Course Outcomes:

1. Ability to formulate machine learning techniques to respective problems.
2. How to perform the evaluation of learning algorithms and model selection.
3. Apply machine learning algorithms to solve problems of moderate complexity

Detailed Contents:

Unit: 1	**Introduction to Machine Learning** - Defining learning systems, Goals and applications of machine learning in different fields such as health care, banking, telecommunication, digital marketingand so on. Aspects of developing a learning system:: training and testing data, concept representation, function approximation, a general overview of supervised, semi-supervised, unsupervised learning algorithms and the usage of each algorithm.
Unit: 2	**Basics of Python:** Introduction to Python, **Control structure and function:** if-elif-else, while loop, for loop, break and continue,Introduction to function, Types of functions, Function arguments, Lambda functions, File Handling, packages and modules. **Python Data Structures:** Lists, Tuples, Dictionary, Sets, strings, **Numpy:** Numpy operation, Array and its operation, Matrix and associated operations, Linear algebra and related operations using python. Understand the advantage of using Python libraries for implementing Machine Learning models. Types of data sets.
Unit: 3	**Pandas data frame and data frame related operations on dataset :** Readingand writing data files, pandas append, insert, replace, dropping columns from dataframe, groupby and aggregate function, join operations, Exploratory data analysis, Data preparation and preprocessing (Dealing with missing value, cross-validation, classification, performance measure), **Data visualization on dataset using matplotlib and seaborn libraries:** Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot.
Unit: 4	**Introduction to Regression** - Linear, Non-linear, Simple and Multiple regression, and their applications, **Introduction to Classification technique** - KNN, ANN, Decision Trees and SVM. Pros and cons of each method, and different classification accuracy metrics.
Unit: 5	**Introduction to clustering approaches** - Types of clustering, including k-means clustering, Partitioned-based Clustering, Hierarchical Clustering, and Density-based Clustering. **Decision Tree Learning:** - Minimum Description Length Principle. Occam's razor. Learning with active queries Introduction to information theory, Decision Trees, Cross Validation and Over fitting. **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.

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

Text Books:

1	Tom Michel, Machine Learning, McGraw Hill, 1997
2	Introduction to Machine Learning with Python, Andreas C. Mueller
3	**Mastering Python for data science, Samir Madhavan**

Reference Books:

1	Machine Learning Methods in the Environmental Sciences, Neural Networks, William W Hsieh, Cambridge Univ Press.
2	McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython.

Course Code	Course Title	Lecture			
MTCS260PCP	**Machine Learning with Python - LAB**	**L**	**T**	**P**	**Semester:** II
Version:	**Date of Approval:**	0	0	4	

Scheme of Instruction			**Scheme of Examination**		
Total Duration	:	30 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Practical	Exam Duration	:	3 Hrs.

PRE-REQUISITES: Knowledge of basic data science algorithms

Course Objectives:

1. The course aims at equipping participants to be able to use python programming for solving data science problems.
2. To study python for the implementation of data science.

Course Outcomes:

1. Develop an appreciation for what is involved in learning from data.
2. How to implement a variety of data science problems.

Detailed Contents:

Lab experiments are based on the syllabus prescribed for Machine learning algorithm using python.
1. Basic data structures and operations of python programming.
2. Write the python code for data cleaning the data (Note: Don't import repackage in python)
3. Write the python code for finding the Euclidean distance between two data points.
4.. Write a python code for handling the missing value feature in the provided data set
5. Implementation of k-nearest neighbours (KNN) algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.
6. Implement the classification problem, training and testing data can be used to build classification models.
7. Implement the class of accuracy metrics for classification: precision, recall, f1 score, accuracy score,
8. Implementation of K -Means algorithm.
9. Implementation of Decision Tree-based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
10. Implementation of the Random Forest algorithm.
11. Implementation of Naive Bayesian classifier for a sample training data set stored as a.CSV file. Compute the accuracy of the classifier, considering few test data sets.
12. Implementation of Simple Linear Regression using sklearn,
13. Implementation of regression using ordinary least squares method,
14. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
15. Implementation of Different multi-class SVM techniques using Binary class SVM library.
16. Case study: Predicting the price of pre-owned cars, Classifying personal income
17. Implementation of CNN using Tensorflow/Keras library and classify the Images (Note: Take your own dataset of your choice)
18. Implementation of Grid search and Random search using Logistic Regression.

Examination and Evaluation Pattern: It includes both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	Mastering python for data science, Samir Madhavan
2	Introduction to linear algebra - by Gilbert Strang
3	Machine Learning using Python, U Dinesh Kumar Manaranjan Pradhan

Reference Books:

1	Applied statistics and probability for engineers – by Douglas Montgomery
2	McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media,

Course Code	Course Title	Lecture			
MTCS212PCP	**Internet of Things**	**L**	**T**	**P**	**Semester:** II
Version:	**Date of Approval:**	4	0	4	

Scheme of Instruction			**Scheme of Examination**		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	30
Credits	:	2	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

1. Vision and Introduction to IoT.
2. Understand IoT Market perspective.
3. Data and Knowledge Management and use of Devices in IoT Technology.
4. Understand State of the Art – IoT Architecture.

Course Outcomes:

1. be able to explain and demonstrate various components of Internet of Things (IoT);
2. be able to analyse the role and importance of IoT in the modern world;
3. be able to investigate and propose various requirements of IoT for real world applications;
4. be able to evaluate a variety of existing and developing architecture technologies for IoT;
5. be able to describe and evaluate different applications of the IoT.

Detailed Contents:

Unit: 1	Introduction to IoT, IOT Architecture, Sensing, Actuation, Basics of Networking, Basics of Networking Communication Protocols.
Unit: 2	Communication Protocols, Sensor Networks, Machine-to-Machine Communications and Introduction to SDN, SDN for IoT.
Unit: 3	Interoperability in IoT, Introduction to Arduino Programming, IoT development tools/platforms, Integration of Sensors and Actuators with Arduino, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi.
Unit: 4	IOT based Cloud Computing, Sensor-Cloud, Fog Computing, Smart Cities and Smart Homes, Data Handling and Analytics.
Unit: 5	IOT Based Connected Vehicles, Smart Grid, Industrial IoT. Applications of IOT, Case Study: Agriculture, Healthcare, Activity Monitoring, Implementation of IoT concepts.

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	Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press).
2	The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by Pethuru Raj and Anupama C. Raman (CRC Press).

Reference Books:

1	Buyya, R., & Dastjerdi, A. V. (Eds.). (2016). Internet of Things: Principles and paradigms. Elsevier.
2	Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting everything”, 1st Edition, Apress Publications, 2013.

Course Code	Course Title	Lecture			Semester: II
MTCS261PCP	Internet of Things Lab	L	T	P	
Version:	Date of Approval:	0	0	4	

Scheme of Instruction			Scheme of Examination		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	4	Internal Evaluation	:	50
Credits	:	2	End Semester	:	50
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Course Objectives:

2. Understanding IoT and the role of the Cloud in IoT
3. Understanding IoT development platforms like Arduino, Raspberry Pi.
4. Understanding IoT Sensors and Thingspeak.

Course Outcomes:

A student passing this course should be able to:

1. Understand core the concept of IoT development.
2. Understand the concept of Sensors, actuators and cloud.

Detailed Contents:

1. Study and Install IDE of Arduino and different types of Arduino.
2. Write program using Arduino IDE for Blink LED.
3. Write Program for RGB LED using Arduino.
4. Study the Temperature sensor and Write Program for monitor temperature using Arduino.
5. Study and Implement RFID, NFC using Arduino.
6. Study and implement MQTT protocol using Arduino.
7. Study and Configure Raspberry Pi.
8. WAP for LED blink using Raspberry Pi
9. Study and Implement Zigbee Protocol using Arduino / Raspberry Pi.
10. To understand what is cloud, its importance, usage, services and types of Cloud.
11. To familiarize with ThingSpeak and understand the procedure of creation of a Channel over ThingSpeak.
12. To upload DHT11 sensor data to ThingSpeak channel through Raspberry pi2.
13. To upload Light sensor (TSL) data to ThingSpeak channel through Raspberry pi2
14. To read Light Sensor data from ThingSpeak channel and store it into database through Raspberry pi2.

Examination and Evaluation Pattern: It include both internal evaluation (50 marks) comprising two class sessional exams/ assignments/ quiz/ seminar presentation etc. and external evaluation (50 marks) which is mainly end semester examination.

Text Books:

1	Bahga, A., & Madisetti, V. (2014). Internet of Things: A hands-on approach. Vpt.
2	Veneri, G., & Capasso, A. (2018). Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0. Packt Publishing Ltd.

Reference Books:

1	Seneviratne, P. (2018). Hands-On Internet of Things with Blynk: Build on the power of Blynk to configure smart devices and build exciting IOT projects. Packt Publishing Ltd.
2	Ziemann, V. (2018). A hands-on course in sensors using the Arduino and Raspberry Pi. CRC Press.

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS211PET	Blockchain Technology (Elective-3)				
Version:	Date of Approval:	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:

1. To understand the function of Blockchain as a method of securing distributed ledgers.
1. To familiarise the functional/operational aspects of cryptocurrency ecosystem.
2. To familiarise about wallets and learn their utilization of wallet during transaction.
3. To understand that how to write and apply the Smart Contracts.
4. To understand the concept of Hyperledger.

Course Outcomes:

1. To be able to implement the blockchain
2. To be able to implement the smart contracts on Ethereum platform.
3. To be able to implement the use cases on Hyperledger.
4. To be able to identify the major research challenges and technical gaps existing between theory and practice in Blockchain

Detailed Contents:

Unit: 1	Introduction to Cryptography, Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, Euclid's Algorithm, RSA algorithm, Diffie-Hellman key exchange algorithm, ElGamal Encryption, Elliptic curve cryptography, SHA 256, Digital Signature, Zero Knowledge Proof (ZKP)
Unit: 2	Introduction from barter system to Cryptocurrency, fundamental of Blockchain, Block structure, Genesis Block, Orphaned Blocks, Stale Block, Uncle Block, Distributed Ledger Technology (DLT), peer-to- peer network, Merkle Tree, Lifecycle of Blockchain, Evolutions of Blockchain, Fork, double spending money, Transactions and UTXO's, Types of Blockchain. Need of Blockchain, Benefits of Blockchain.
Unit: 3	Build the Blockchain, Chain validation, Create the Blockchain Network, Mining pools, Mining, Difficulty Level, Current Target, Nonce, how miners picks transactions, Work of mempools work, 51% attack. Consensus Algorithms: Proof of Work (PoW), Asynchronous Byzantine Agreement, Proof of Stake (PoS), Hybrid models (PoW + PoS), DPoS.
Unit: 4	Wallets, Types of wallets-Hardware, Software, Paper, Web, Desktop. Ethereum - Ethereum network, Ethereum Virtual Machine (EVM), Wallets for Ethereum, Solidity - Smart Contracts, Truffle, Web3, some attacks on smart contracts, Design and issue Cryptocurrency ICO, Mining, Gas - Transactional Fee & Incentivisations, DApps, Decentralized Autonomous Organizations (DAO). Implement the use case of supply chain on Ethereum.
Unit: 5	Introduction to Hyperledger, What is Hyperledger, Why Hyperledger, Where can Hyperledger be used, Hyperledger Architecture, Membership, Blockchain, Transaction, Chaincode, Hyperledger Fabric, Features of Hyperledger, Fabric Installation of prerequisite, Architecture of Hyperledger Fabric, Transaction, Ledger, Nodes, Peer, Endorser, Ordering Nodes, Channels, Certificate Authority, Transaction Flow. Implement the use case of supply chain on Hyperledger.

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	Mastering Blockchain, Imran Bashir, Packt Publishing
2	Bitcoin and Cryptocurrency Technologies, Arvind Narayanan, Joseph Bonneau, Edward Felten,Andrew Miller, Steven Goldfeder, Princeton University Press. https://bitcoinbook.cs.princeton.edu/

Reference Books:

1	Grokking Bitcoin, Kalle Rosenbaum, Manning Publications. http://rosenbaum.se/book/grokking-bitcoin.html
2	Blockchain Basics, Daniel Drescher, Apress Publicationhttp://vlabs.iitb.ac.in/vlabs-dev/labs/blockchain/labs/index.php

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS212PET	Compilers for High Performance Computing (Elective-3)	4	0	0	
Version:	Date of Approval:				

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:

1. To introduce structure of compilers and high performance compiler design
2. To understand the Concepts of Data Dependance in compilation
3. To consider concurrency analysis in translation
4. To understand cache coherence and parallel loops in compilers

Course Outcomes:

After completion of course, students would be

1. Familiar with the structure of compiler.
2. Parallel loops, data dependency and exception handling and debugging in compiler.

Detailed Contents:

Unit: 1	High Performance Systems, Structure of a Compiler, Programming Language Features, Languages for High Performance, Data Dependence: Data Dependence in Loops, Data Dependence in Conditionals, Data Dependence in Parallel Loops, Program Dependence Graph.
Unit: 2	Scalar Analysis with Factored Use-Def Chains: Constructing Factored UseDef Chains, FUD Chains for Arrays, Induction Variables Using FUD Chains, Constant Propagation with FUD Chains, Data Dependence for Scalars. Data Dependence Analysis for Arrays, Array Region Analysis, Pointer Analysis, I/O Dependence, Procedure Calls, Inter-procedural Analysis.
Unit: 3	Loop Restructuring: Simple Transformations, Loop Fusion, Loop Fission, Loop Reversal, Loop Interchanging, Loop Skewing, Linear Loop Transformations, Strip-Mining, Loop Tiling, Other Loop Transformations, and Inter-procedural Transformations, Optimizing for Locality: Single Reference to Each Array, Multiple References, General Tiling, Fission and Fusion for Locality.
Unit: 4	Concurrency Analysis: Concurrency from Sequential Loops, Concurrency from Parallel Loops, Nested Loops, Round off Error, Exceptions and Debuggers. Vector Analysis: Vector Code, Vector Code from Sequential Loops, Vector Code from For all Loops, Nested Loops, Round off Error, Exceptions, and Debuggers, Multi-vector Computers.
Unit: 5	Message-Passing Machines: SIMD Machines, MIMD Machines, Data Layout, Parallel Code for Array Assignment, Remote Data Access, Automatic Data Layout, Multiple Array Assignments, Scalable Shared-Memory Machines: Global Cache Coherence, Local Cache Coherence, Latency Tolerant Machines. Recent trends in compiler design for high performance computing and message passing machines and scalable shared memory machine.

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	Michael Wolfe, High-Performance Compilers for Parallel Computing, Pearson
2	Keith Cooper, Linda Torczon, Engineering: A Compiler, MK Publishers

Reference Books:

1	Robert Robey and Yuliana Zamora, Parallel and High Performance Computing, Manning Publications
2	Randy Allen and Ken Kennedy, Optimizing Compilers for modern architectures, MK Publishers

Course Code	Course Title	Lecture			Semester II
		L	T	P	
MTCS213PET	Distributed Computing (Elective-3)				
Version:	Date of Approval:	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:

1. To introduce concepts related to distributed computing systems.
2. To focus on performance and flexibility issues related to systems design decisions.
3. To expose students to current literature in distributed systems.

Course Outcomes:

1. Demonstrate knowledge of the basic elements and concepts related to distributed system technologies.
2. Demonstrate knowledge of the core architectural aspects of distributed systems.
3. Design and implement distributed applications.

Unit: 1	Characterization of Distributed Systems: Resource sharing and the Web Challenges. Architectural models, Fundamental Models. Theoretical Foundation for Distributed System: Limitation of Distributed system, Logical clocks, Lamport's & vectors logical clocks.
Unit: 2	Concepts in Message Passing Systems: Message Ordering, Causal ordering of messages, global state, and termination detection. Distributed Mutual Exclusion: Classification of distributed mutual exclusion, requirement of Mutual exclusion, Token based and non-token based algorithms.
Unit: 3	Distributed 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	Distributed File system design; Real Time Operating Systems: Introduction to Real Time Operating Systems, Concepts of scheduling, Real time Memory Management. Recovery in Concurrent systems, obtaining consistent Checkpoints, Recovery.
Unit: 5	Distributed Transactions, Commit Protocols, Voting protocols, Dynamic voting protocols. Transactions and Concurrency Control: Transactions, Nested transactions, Locks, Optimistic Concurrency control, Timestamp ordering.

Text Books:

1	Advanced Concepts in Operating Systems, M Singhal, N G Shivarathri, Tata McGraw-Hill Edition.
2	Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", Pearson Ed.

Reference Books:

1	Distributed Systems – Principles and Paradigms, A.S. Tanenbaum and M.V. Steen, Pearson Education
2	Distributed Computing, S.Mahajan and S.Shah, Oxford University Press

Course Code	Course Title	Lecture			Semester:
		L	T	P	
MTCS214PET	Natural Language Processing **(Elective-3)**				II
Version:	**Date of Approval:**	4	1	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:

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To get acquainted with the algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics, as well as the resources of natural language data - corpora.
3. To conceive basics of knowledge representation, inference, and relations to the artificial intelligence.

Course Outcomes: At the end of the course student will be able to:

1. The students will get acquainted with natural language processing and learn how to apply basic algorithms in this field.
2. They will understand the algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics, as well as the resources of natural language processing.
3. They will also grasp basics of knowledge representation, inference, and relations to the artificial intelligence.

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	Morphology: Analysis and generation of language on word level: e.g. problems with compounding and idiomatic phrases, homophonous strings as well as loan words and their processing using e.g. finite state automata as well as semantic networks. Ambiguities in words like "pen" and "pipe", but will also discuss some complex strings.
Unit: 3	Syntax: Analysis and generation of language on phrasal and sentence level: e.g. applications such as machine translation and grammar checking and the processing using phase structure grammars as well as unification-based formalisms and relating those formalisms to recursive transition networks (RTNs) as well as augmented transition networks (ATNs).
Unit: 4	Semantics: Language ambiguities on the level of "meaning": represented by case structures and conceptual dependency structures. We will look at famous utterances such as: Colourless green ideas sleep furiously. And will discuss why the machine runs into problems during analysis, and how these problems can be overcome.
Unit: 5	Applications of NLP: Machine Translation, Grammar Checkers Dictation, Automatic Document Generation, NL Interfaces.

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: II
MTCS215PET	**Quantum Computing (Elective-3)**	**L**	**T**	**P**	
Version:	**Date of Approval:**	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:

1. The course will provide an insight of basic of quantum physics from a computer scientist's perspective, and how it describes reality and understand the philosophical implications of quantum computing

Course Outcomes:

1. Knowledge of Vector spaces, Matrices, Quantum state, Density operator and Quantum Measurement theory.

Detailed Contents:

Unit: 1	Qubit & Quantum States: The Qubit, Vector Spaces. Linear Combination Of Vectors, Uniqueness of a spanning set, basis & dimensions, inner Products, orthonormality, gram-schmidt orthogonalization, bra-ket formalism, the Cauchy- schwarez and triangle Inequalities.
Unit: 2	Matrices & Operators: Observables, The Pauli Operators, Outer Products, The Closure Relation, Representation of operators using matrices, outer products & matrix representation, matrix representation of operators in two dimensional spaces, Pauli Matrix, Hermitian unitary and normal operator, Eigen values & Eigen Vectors, Spectral Decomposition, Trace of an operator, important properties of Trace, Expectation Value of Operator, Projection Operator, Positive Operators,
Unit: 3	Commutator Algebra, Heisenberg uncertainty principle, polar decomposition & singular values, Postulates of Quantum Mechanics.
Unit: 4	Tensor Products: Representing Composite States in Quantum Mechanics, Computing inner products, Tensor products of column vectors, operators and tensor products of Matrices. Density Operator: Density Operator of Pure & Mix state, Key Properties, Characterizing Mixed State, Practical Trace & Reduce Density Operator, Density Operator & Bloch Vector.
Unit: 5	Quantum Measurement Theory: Distinguishing Quantum states & Measures, Projective Measurements, Measurement on Composite systems, Generalized Measurements, Positive Operator- Valued Measures. Recent trends in Quantum Computing Research, Quantum Computing Applications of Genetic Programming.

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	Quantum Computing without Magic by Zdzislaw Meglicki
2	Quantum Computing Explained By DAVID Mc MAHON

Reference Books:

1	Quantum Computer Science By Marco Lanzagorta, Jeffrey Uhlmann
2	An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca.

Course Code	Course Title	Lecture			SEMESTER II
		L	T	P	
MTCS221PET	Advanced Operating System (Elective-4)				
Version:	Date of Approval:	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:

1. To read classic systems papers that shaped the field.
2. To present technical materials to others both orally and in written form.
3. To improve the accuracy and precision with which you express ideas.

Course Outcomes:

1. Master understanding of design issues associated with operating systems.
2. Master various process management concepts including scheduling, synchronization, and deadlocks.
3. Be familiar with various types of operating systems including UNIX.

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; Schedulingscheduling 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.

Text Books:

1. MukeshSinghal 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, 2ndEdition, 2001.
2. Pradeep K. Sinha, “Distributed Operating Systems and concepts”, PHI, First Edition, 2002

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS222PET	Digital Image Processing (Elective-4)				
Version:	Date of Approval:	4	1	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.

Prerequisite(s): It is expected that the students have done BTCS615PET course

Course Objectives:

1. Imparts knowledge in the area of image and image processing.
2. Understand fundamentals of digital image processing.
3. Provide knowledge of the applications of the theories taught in Digital Image Processing. This will be achieved through the project and some selected lab sessions.

Course Outcomes:

1. Understand Basics of Image formation and transformation using sampling and quantization.
2. Understand different types signal processing techniques used for image sharpening and smoothing.
3. Perform and apply compression and coding techniques used for image data.

Detailed Contents:	
Unit: 1	**Introduction to Image Processing:** Image formation, image geometry perspective and other transformation, stereo imaging elements of visual perception.Digital Image-sampling and quantization serial & parallel Image processing.
Unit: 2	**Signal Processing:** Signal Processing - Fourier, Walsh-Hadmard discrete cosine and Hotelling transforms and their properties, filters, correlators and convolvers. Image enhancement-Contrast modification, Histogram specification, smoothing, sharpening, frequency domain enhancement, pseudo-colour
Unit: 3	**Image Restoration:** Image Restoration-Constrained and unconstrained restoration Wiener filter , motion blur remover, geometric and radiometric correction Image data compression-Huffman and other codes transform compression, predictive compression two tone Image compression, block coding, run length coding, and contour coding.
Unit: 4	**Segmentation Techniques:** Segmentation Techniques-thresh holding approaches, region growing, relaxation, line and edge detection approaches, edge linking, supervised and unsupervised classification techniques, remotely sensed image analysis and applications.
Unit: 5	**Shape Analysis:** Shape Analysis – Gestalt principles, shape number, moment Fourier and other shape descriptors, Skelton detection, Hough transform, topological and texture analysis, shape matching. Practical Applications – Finger print classification, signature verification, text recognition, map understanding, bio-logical cell classification.

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. Gonzalez and Wood, “Digital Image Processing”, Addison Wesley, 1993.
2. Anil K.Jain, “Fundamental of Image Processing”, Prentice Hall of India.

Reference Books:

1. Rosenfeld and Kak, “Digital Picture Processing” vol.I&vol.II, Academic,1982
2. Ballard and Brown, “Computer Vision”, Prentice Hall, 1982

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS223PET	Advanced Wireless & Mobile Networks (Elective-4)	3	0	0	
Version:	Date of Approval:				

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

Course Objectives:

1. The students should get familiar with the wireless/mobile market and the future needs and challenges.
2. To get familiar with key concepts of wireless networks, standards, technologies and their basic operations.
3. To learn how to design and analyse various medium access.
4. To learn how to evaluate MAC and network protocols using network simulation software tools.
5. The students should get familiar with the wireless/mobile market and the future needs and challenges.

Course Outcomes:

After completion of course, students would be:

1. Demonstrate advanced knowledge of networking and wireless networking and understand various types of wireless networks, standards, operations and use cases.
2. Be able to design WLAN, WPAN, WWAN, Cellular based upon underlying propagation and performance analysis.
3. Demonstrate knowledge of protocols used in wireless networks and learn simulating wireless networks.
4. Design wireless networks exploring trade-offs between wire line and wireless links.
5. Develop mobile applications to solve some of the real world problems.

Detailed Contents:

Unit: 1	**Introduction:** Wireless Networking Trends, Key Wireless Physical Layer Concepts, Multiple Access Technologies -CDMA, FDMA, TDMA, Spread Spectrum technologies, Frequency reuse, Radio Propagation and Modelling, Challenges in Mobile Computing: Resource poorness, Bandwidth, energy etc. **Wireless Local Area Networks:** IEEE 802.11 Wireless LANs Physical & MAC layer, 802.11 MAC Modes (DCF & PCF) IEEE 802.11 standards, Architecture & protocols, Infrastructure vs. Adhoc Modes, Hidden Node & Exposed Terminal Problem, Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues.
Unit: 2	**Wireless Cellular Networks:** 1G and 2G, 2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks, Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity in cellular systems, Spread spectrum Technologies.
Unit: 3	WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE 802.22 Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover Overview **Wireless Sensor Networks:** Introduction, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS Overview.
Unit: 4	**Wireless PANs:** Bluetooth AND Zigbee, Introduction to Wireless Sensors. **Security:** Security in wireless Networks Vulnerabilities, Security techniques, Wi-Fi Security, DoS in wireless communication.
Unit: 5	**Advanced Topics:** IEEE 802.11x and IEEE 802.11i standards, Introduction to Vehicular Adhoc Networks, Opportunistic 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	Schiller J., Mobile Communications, Addison Wesley 2000.
2	Stallings W., Wireless Communications and Networks, Pearson Education 2005.

Reference Books:

1	Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc 2002.
2	Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc 2000.

Course Code	Course Title	Lecture			Semester:
MTCS224PET	Mobile Applications and Services **(Elective-4)**	**L**	**T**	**P**	II
Version:	**Date of Approval:**	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:

4. This course presents the three main mobile platforms and their ecosystems, namely Android, iOS, and PhoneGap/WebOS.
5. It explores emerging technologies and tools used to design and implement feature-rich mobile applications for smartphones and tablets.
6. It also takes into account both the technical constraints relative to storage capacity, processing capacity, display screen, communication interfaces, and the user interface, context and profile.

Course Outcomes:

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

1. Identify the target platform and users and be able to define and sketch a mobile application
2. Understand the fundamentals, frameworks, and development lifecycle of mobile application platforms including iOS, Android, and PhoneGap
3. Design and develop a mobile application prototype in one of the platforms (challenge project)

Detailed Contents:

Unit: 1	Introduction: Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User
Unit: 2	More on Uis: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal Uis, Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider
Unit: 3	Communications via Network and the Web: State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony
Unit: 4	Notifications and Alarms: Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Android Services
Unit: 5	Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia Platforms and Additional Issues: Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions, More on Security, Hacking Android

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	Wei-Meng Lee, Beginning Android™ 4 Application Development, 2012 by John Wiley & Sons.
2	Hands-On Swift 5 Microservices Development, Build microservices for mobile and web applications using Swift 5 and Vapor 4, Ralph Kuepper, Tanner Nelson

Reference Books:

1	Xamarin Mobile Application Development: Cross-Platform C# and Xamarin.Forms Fundamentals
2	Android Programming: The Big Nerd Ranch Guide (3rd Edition)

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS225PET	**GPU Computing (Elective-4)**				
Version:	**Date of Approval:**	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:

2. To learn parallel programming with Graphics Processing Units (GPUs).

Course Outcomes:

3. Students would learn concepts in parallel programming, implementation of programs on GPUs, debugging and profiling parallel programs.

Detailed Contents:	
Unit: 1	Introduction: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA OpenCL / OpenACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps / Wavefronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D / 3D thread mapping, Device properties, Simple Programs
Unit: 2	Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories
Unit: 3	Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.
Unit: 4	Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based-Synchronization - Overlapping data transfer and kernel execution, pitfalls.
Unit: 5	Image Processing, Graph algorithms, Simulations, Deep Learning. Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing

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	Programming Massively Parallel Processors: A Hands
2	CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012 (ISBN: 978
Reference Books:	

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS231GET	CONSTITUTION OF INDIA (Generic Elective-2)				
Version:	Date of Approval:	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:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik
4. Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Detailed Contents:

Unit: 1	**History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working), **Philosophy of the Indian Constitution:** Preamble Salient Features
Unit: 2	**Contours of Constitutional Rights & Duties:** Fundamental Rights**,** Right to Equality**,** Right to Freedom**,** Right against Exploitation**,** Right to Freedom of Religion**,** Cultural and Educational Rights**,** Right to Constitutional Remedies**,** Directive Principles of State Policy**,** Fundamental Duties.
Unit: 3	**Organs of Governance:** Parliament**,** Composition**,** Qualifications and, Disqualifications**,** Powers and Functions**,** Executive**,** President**,** Governor Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions
Unit: 4	**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy
Unit: 5	**Election Commission:** Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioner, State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

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 Constitution of India, 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

Reference Books

1	M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
2	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS232GET	PEDAGOGY STUDIES (Generic Elective-2)				
Version:	Date of Approval:	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:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Detailed Contents:

Unit: 1	**Introduction and Methodology:**: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.
Unit: 2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.
Unit: 3	Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.
Unit: 4	Professional development: alignment with classroom practices and follow-up support, Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes
Unit: 5	**Research gaps and future directions:** Research design**,** Contexts Pedagogy**,** Teacher education**,** Curriculum and assessment**,** Dissemination and research impact.

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. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools. Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum

Reference Books

1. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research
2. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and

Course Code	Course Title	Lecture			Semester: II
		L	T	P	
MTCS233GET	STRESS MANAGEMENT BY YOGA (Generic Elective-2)				
Version:	Date of Approval:	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:

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Detailed Contents:

Unit: 1	Definitions of Eight parts of yog. (Ashtanga)
Unit: 2	Yam and Niyam. Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha
Unit: 3	Shaucha, santosh, tapa, swadhyay, ishwarpranidhan
Unit: 4	Asan and Pranayam, Various yog poses and their benefits for mind & body
Unit: 5	Regularization of breathing techniques and its effects-Types of pranayam

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	'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2	"Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Reference Books:

Course Code	Course Title	Lecture			
		L	T	P	
MTCS234GET	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Generic Elective-2)				Semester: II
Version:	Date of Approval:	3	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:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course Outcomes:

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

Detailed Contents:

Unit: 1	Neetisatakam-Holistic development of personality Verses- 19,20,21,22 (wisdom) Verses- 29,31,32 (pride & heroism) Verses- 26,28,63,65 (virtue) Verses- 52,53,59 (dont's) Verses- 71,73,75,78 (do's)
Unit: 2	Approach to day to day work and duties. Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35,
Unit: 3	Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48. Statements of basic knowledge. Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
Unit: 4	Chapter 12 -Verses 13, 14, 15, 16,17, 18 Personality of Role model. Shrimad Bhagwad Geeta:
Unit: 5	Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

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	"Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2	Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Reference Books

Semester-3

Course Code	Course Title	Lecture			Semester: III
		L	T	P	
MTCS311PET	Deep Learning (Elective-5)				
Version:	Date of Approval:	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:

1. To introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.

Course Outcomes:

1. Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
2. Implement deep learning algorithms and solve real-world problems.

Detailed Contents:

Unit: 1	History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs
Unit: 2	Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis, Principal Component Analysis and its interpretations, Singular Value Decomposition, Autoencoders and relation to PCA
Unit: 3	Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders, Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization
Unit: 4	Learning Vectorial Representations Of Words, Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Object Detection, RCNN, Fast RCNN, Faster RCNN, YOLO.
Unit: 5	Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated, BPTTGated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanidhing gradient problem with LSTMs

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	Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2	https://www.cse.iitm.ac.in/~miteshk/CS7015.html

Reference Books:

1	Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
2	Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.

Course Code	Course Title	Lecture			Semester: III
		L	T	P	
MTCS312PET	Secure Software Design &Enterprise Computing (Elective-5)				
Version:	Date of Approval:	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:

1. To fix software flaws and bugs in various software.
2. To make students aware of various issues like weak random number generation, Information leakage, poor usability, and weak or no encryption on data traffic.
3. Techniques for successfully implementing and supporting network services on anenterprise scale and heterogeneous systems environment.
4. Methodologies and tools to design and develop secure software containing minimumvulnerabilities and flaws.

Course Outcomes:

1. Differentiate between various software vulnerabilities.
2. Software process vulnerabilities for an organization.
3. Monitor resources consumption in a software.
4. Interrelate security and software development process.

Detailed Contents:

Unit: 1	**Secure Software Design** Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, Perform security testing and quality assurance.
Unit: 2	**Enterprise Application Development** Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, Develop components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution.
Unit: 3	**Enterprise Systems Administration** Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, Monitor server resource utilization for system reliability and availability, Install and administer network services(DNS/DHCP/Terminal Services/Clustering/Web/Email).
Unit: 4	Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to goabout managing them.
Unit: 5	Handle insecure exceptions and command/SQL injection, Defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws. Case study of DNS server, DHCP configuration and SQL injection attack.

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	Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett

Reference Books:

1	Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software

Course Code	Course Title	Lecture			
MTCS313PET	**Wireless Access Technologies (Elective-5)**	**L**	**T**	**P**	**Semester:** III
Version:	**Date of Approval:**	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:

1. Overview of wireless access technologies, Fixed wireless access networks. Terminal mobility issues regarding wireless access to Internet
2. Introduction to various Network topologies, hotspot networks, Communication links: point-to-point, point-to-multipoint, multipoint-to-multipoint.
3. To provide an overview of Standards for most frequently used wireless access networks: WPAN, UWB, WLAN, WMAN, WWAN. Network services. Wireless access networks planning, design and installation.
4. To get and insight of Wireless networking security issues, Wireless access network exploitation and management, software requirements, link quality control.

Course Outcomes:

1. interpret basic terms and characteristics of wireless access networks
2. compare various wireless access technologies
3. analyze measurements of wireless access network parameter
4. assess security issues in wireless networks
5. choose modulation technique for wireless transmission

Detailed Contents:

Unit: 1	Necessity for wireless terminals connectivity and networking. Wireless networking advantages and disadvantages, Overview of wireless access technologies. Narrowband and broadband networks, fixed and nomadic networks. Wireless local loop (WLL), Public Switched Telephone Network (PSTN) interfaces.
Unit: 2	Fixed wireless access (FWA) networks, frequency bands for different networks. Criterions for frequency bands allocation, Network topologies, hotspot networks. Communication links: point-to-point (PTP), point- to-multipoint (PMP), multipoint-to-multipoint (MTM).
Unit: 3	Standards for most frequently used wireless access networks: WPAN (802.15, Bluetooth, DECT, IrDA), UWB (Ultra-Wideband), WLAN (802.11, Wi-Fi, HIPERLAN, IrDA), WMAN (802.16, WiMAX, HIPERMAN, HIPERACCESS), WWAN (802.20), Other technologies for broadband wireless access, Local Multipoint Distribution Service (LMDS), Multichannel Multipoint Distribution Service (MMDS). Ad -Hoc networks, Network services. Services types based on carrier frequency and bandwidth.
Unit: 4	Wireless access networks planning, design and installation. Services provision, legislative and technical aspects, Technical and economical factors for network planning: expenses, coverage, link capacity, network complexity and carrier-to-interference ratio (C/I). Base station or access point allocation. Base station and access point equipment. Terminal mobility issues regarding wireless access to Internet. Wireless networking security issues.
Unit: 5	Example of laptop or handheld PC wireless connection in real environment. PC wireless interface equipment. Wireless access network exploitation and management, software requirements, link quality control. Business model, wireless network services market, market research and marketing, service providers, wireless data application service providers (WDASP) and their role on public telecommunication services market, billing systems. Recent trends in wireless networking and various access mechanism, new standards of wireless communication.

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	M. P. Clark, Wireless Access Networks: Fixed Wireless Access and WLL networks -- Design and Operation, John Wiley & Sons, Chichester
2	D. H. Morais, Fixed Broadband Wireless Communications: Principles and Practical Applications, Prentice Hall, Upper Saddle River

Reference Books:

1	R. Pandya, Introduction to WLLs: Application and Deployment for Fixed and Broadband Services, IEEE Press, Piscataway.

Course Code	Course Title	Lecture			Semester III
MTCS314PET	Data preparation and Analysis (Elective-5)	L	T	P	
Version:	Date of Approval:	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:

1. To prepare the data for analysis
2. develop meaningful Data Visualizations

Course Outcomes: After completion of course, students would be able

1. To extract the data for performing the Analysis.

Detailed Contents

Unit: 1	Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues
Unit: 2	Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and Segmentation
Unit: 3	Exploratory Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis Generation
Unit: 4	Visualization: Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity
Unit: 5	Visualizations using R

Text Books:

1	Making sense of Data : A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn

Course Code	Course Title	Lecture			
MTCS315PET	**Optimization Techniques (Elective-5)**	**L**	**T**	**P**	**Semester: III**
Version:	**Date of Approval:**	4	0	0	

Scheme of Instruction			**Scheme of Examination**		
No. of Periods	:	60 Hrs.	Maximum Score	:	100
Periods/ Week	:	6	Internal Evaluation	:	30
Credits	:	4	End Semester	:	70
Instruction Mode	:	Lecture	Exam Duration	:	3 Hrs.

Prerequisite(s): It is expected that the students have done any programming language course

Course Objectives:

1. To provide insight to the mathematical formulation of real world problems.
2. To optimize these mathematical problems using nature based algorithms.
3. And the solution is useful especially for NP-Hard problems.

Course Outcomes: The Students will be able to :

1. Formulate and solve linear Programming Problems
2. Determine the optimum solution to constrained and unconstrained
3. Apply dynamic programming principle to Linear programming problems.
4. Determine the integer solutions to Linear Programming Problems

Detailed Contents:

Unit: 1	Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem - Optimal Problem formulation - Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria - Review of basic calculus concepts – Global optimality
Unit: 2	Linear Programming: Introduction and formulation of models, Convexity, Simplex method, BigM method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .
Unit: 3	Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.
Unit: 4	Dynamic Programming: Principle of optimality, recursive relations, solution of LPP. Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method - Engineering applications of constrained and unconstrained algorithms.
Unit: 5	Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem. Modern methods of Optimization: Genetic Algorithms - Simulated Annealing - Ant colony optimization - Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications. Use of Matlab to solve optimization problems. Software: Introduction to software for optimization techniques (TORA).

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	Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand & Co., 2006
2	J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008

Reference Books

1	N.S.Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.
2	