R23(B. Tech Data Science)

Curriculum & Syllabus for B. Tech Under Autonomy (NEP 2020 Implemented)

Data Science

(Effective from 2023-24 admission batch)

Department: Data Science

Curriculum Structure & Syllabus

(Effective from 2023-24 admission batch)

1st Year 1st Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	DS101	Programming for Problem Solving	3	0	0	3	3
2	SCI	Multidisciplinary	CH(DS) 101	Engineering Chemistry	2	0	0	2	2
3	SCI	Multidisciplinary	M(DS)101	Engineering Mathematics	3	0	0	3	3
4	HUM	Ability Enhancement Course	HU101	Professional Communication	2	0	0	2	2
5	HUM	Value added course	HU102	Values and Ethics	2	0	0	2	2
6	HUM	Value added course	HU103	Constitution of India	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	DS191	Programming for Problem Solving Lab	0	0	3	3	1.5
2	HUM	Ability Enhancement Course	HU191	Professional Communication Lab	0	0	2	2	1
3	SCI	Skill enhancement	CH(DS)191	Engineering Chemistry Lab	0	0	2	2	1
4	ENGG	Skill enhancement course	ME(DS)191	Workshop & Manufacturing Practices Lab	0	0	3	3	1.5
Total of Theory, Practical								23	18

HUM: Humanities; ENGG: Engineering; SCI: Science; PRJ : Project

Course Name: PROGRAMMING FOR PROBLEM SOLVING
Course Code: DS101
Contact (Periods/Week):3L/Week
Total Contact Hours: 36
Credits: 3

Course Outcome(s):

CO1: To identify the working principle of input and output devices of Computers memorize the basic terminology used in computer programming.

CO2: To express programs in C language and use different data types for writing the programs.

CO3: To implement programs using the dynamic behaviour of memory by the use of pointers.

CO4: To explain the difference between call by value and call by address.

CO5: To write programs using basic data files and developing applications for real world problems.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO112	PSO1	PSO2	PSO3
CO1	3	3	3	2	2						2	3	2	3	3
CO2	2	2	3	3	3							3	2	2	3
CO3	2	3	2	2	2							3	2	3	2
CO4	3	2	2	3	3							2	2	2	2
CO5	2	2	2	1	1						2	3	3	3	3

Course Content:

Module-1: Fundamentals of Computer 9L

History of Computer, Generation of Computer, Classification of Computers, Basic structure of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices.

Number System: basic of Binary, Octal, Decimal and Hexadecimal number systems; Representation and interchanging of number in different number systems. Introduction to complements system, Representation of signed and unsigned numbers in singed magnitude singed 1's complement system and signed 2's complement system.

Arithmetic– Addition and Subtraction (using1'scomplementand2'scomplement). Representation of Characters-ASCII Code, Basics of Compiler, Interpreter and Assembler

Problem solving – Basic concept of Algorithm. Representation of algorithm using flow chart and pseudo code, Some basic examples.

Module-2: Introduction to C Programming 5L

Overview of Procedural vs Structural language; History of C Programming Language. Variable and Data Types: The C characters identifiers and keywords, data type & sizes, variable names, declaration, statements.

Operators & Expressions: Arithmetic operators, relational operators, Logical operators, increment and decrement operators, bitwise operators, Assignment operators, conditional operators, special operators-type conversion, C expressions, precedence and associativity.
Input and Output: Standard input and output, formatted output–print f, formatted input scan f.

Module-3: Branch and Loop 5L

Branching: Concept of Statement and Blocks in C, Simple if, if -else, nested if-else and if-else ladder. Switch Case: break and continue; switch-case, concept of goto and labels
Loops - while, for, do while

Module-4: Program Structures 4L

Function: Basics of Functions, function types, function prototypes, formal and actual parameter, function calling, functions returning values, functions not returning values. Recursion and Recursive Function.
Storage Class in C: Storage Class-auto, external, static and register storage class, scope rules and life time of variables, C pre-processor: Pre-processing directive and macro, parameterized macro.

Module-5: Array and Pointer 7L

Arrays: One dimensional arrays, Two-dimensional arrays
Passing an array to a function Pointers:Pointers, Pointer and Array, Pointer and functions.
Strings: Character array and string, array of strings, Passing a string to a function, String related functions, Pointer and String. Dynamic memory allocation: Malloc, calloc, realloc and free with example.

Module-6: Structures, Unions and Enum 3L

Basic of structures, arrays of structures, structures and pointers, bit fields. Basics of union and enum, difference between structure and union.

Module-7: File in C 3L

Files handling- opening and closing a file in different mode, formatted and unformatted files, Command line arguments, f open, f close, f get c, f put c, f print f, f scan f function.

Textbook:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. Kanetkar Y.-LetusC, BPBPublication,15th Edition

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition

Course Name: ENGINEERING CHEMISTRY
Paper Code: CH(DS)101
Total Contact Hours: 24
Credit: 2

COURSE OBJECTIVE

- To understand the basic principles of elements, organic reactions, drug synthesis and computational chemistry
- To apply the knowledge of different engineering materials, advanced polymers, and nanomaterials to solve complex engineering problems
- To analyse and evaluate quality parameters of water and its treatment
- Apply the knowledge of free energy, energy storage device, semiconductors and corrosion to design environment friendly & sustainable devices
- Apply the knowledge of different instrumental techniques to analyse unknown engineering materials.

COURSE OUTCOME

CO1. Able to understand the basic principles of elements, organic reactions drug synthesis and computational chemistry
CO2. Able to apply the knowledge of different engineering materials, advanced polymers, and nanomaterials to solve complex engineering problems
CO3. Able to analyse and evaluate water quality parameters and its treatment
CO4. Able to the knowledge of free energy, energy storage device, fuels and corrosion to design environment friendly & sustainable devices
CO5. Able to apply the knowledge of different instrumental techniques to analyse unknown engineering materials

CO v/s PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	2	2	2	-	-	-	-	-	2	2
2	3	3	3	3	-	-	2	-	-	-	2	2
3	3	3	-	-	-	-	3	-	-	-	3	2
4	3	3	3	2	-	-	3	-	-	-	3	2
5	3	3	3	3	2	-	-	-	-	-	2	2

COURSE CONTENT

Module 1 - Elements and their properties (6L)

1. **Elements and their properties (3L)**
   Bohr's theory for one electron system, Hydrogen spectrum, Quantum numbers, Atomic orbitals, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle, Electronic configuration and Magnetic properties.
2. **Periodic Table for Engineers (3L)**
   Modern Periodic table, Periodic properties, study of advanced functional materials like Silicones, Silicates, Zeolite and alloys like steel, mischmetall, Neodymium alloy and their applications

Module 2 - Energy devices and Semiconductors (6L)

1. **Use of free energy in chemical equilibria (3L)**
   Laws of Thermodynamics, Enthalpy, Entropy, Spontaneity, Electrochemical Cell, Dry Cell, Mercury Cell, Lead Storage batteries, Ni-Cd Cells, Fuel Cells, Solar Cells, Nernst equation and applications, Electrochemical sensors
2. **Crystals and Semiconductors (3L)**
   Crystals and their defects, Stoichiometric and Non-stoichiometric defects, Band theory and Doping, n-type and p-type semiconductors, Superconductors

Module 3 –Industrial Applications of Chemistry (8L)

1. **Advanced Polymeric materials (3L)**
   Classification, Engineering Plastics, conducting polymers, bio polymers, polymer composites
2. **Industrial corrosion (2L)**
   Classification, Effects of corrosion, Preventive measures
3. **Analysis of Water Quality (1L)**
   Water quality parameters and treatment
4. **Nano materials (1L)**
   Synthesis of Nano materials, Applications in modern devices
5. **Basic Computational Chemistry (1L)**
   Introduction of computational chemistry and their applications

Module 4 – Organic Reaction Products and their spectroscopic analysis (4L)

1. **Organic Reactions (2L)**
   Substitution, Elimination and Addition reactions
2. **Drug designing and synthesis (1L)**
   Paracetamol, Aspirin
3. **Spectroscopic Analysis (1L)**
   UV – Visible Spectra, IR spectra

Suggested Text Books

- Fundamentals of Engineering Chemistry, Dr. Sudip bandopadhyay & Dr. Nirmal Hazra
- Chemistry –I, Gourkrishna Das Mohapatro
- A text book of Engineering Chemistry, Dr. Rajshree Khare
- Engineering Chemistry, U. N. Dhar
- Physical Chemistry, P.C. Rakshit

- **Reference Books**
- Engineering Chemistry, Jain & Jain
- Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishna
- **text book of Engineering Chemistry, Jaya Shree Anireddy**

Course Name: Engineering Mathematics
Paper Code: M(DS)101
Contact (L: T: P): 3 : 0 : 0
Total Contact Hours: 36
Credit: 3

Prerequisites:

The students to whom this course will be offered must have the concept of (10+2) standard matrix algebra, and calculus.

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in matrix algebra and calculus. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes (COs):

On successful completion of the learning sessions of the course, the learner will be able to:

CO1: Recall the properties related to matrix algebra and calculus.

CO2: Determine the solutions of the problems related to matrix algebra and calculus.

CO3: Apply the appropriate mathematical tools of matrix algebra and calculus for the solutions of the problems.

CO4: Analyze different engineering problems linked with matrix algebra and calculus.

CO-PO/PSO Mapping:

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	3	2	2	-	-	-	-	-	-	-	-	1
CO4	2	3	1	2	-	-	-	-	-	-	-	1
M(ME) 101	**2.75**	**2.25**	**1.5**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.25**

Weightage Values: Strongly mapped: ‘3’, Moderately mapped: ‘2’, Weakly mapped: ‘1’, Not mapped: ’-‘.

Course Content:

Module I: Liner Algebra (11L)
Echelon form and normal (canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigenvalues and eigenvectors; Diagonalization of matrix, Cayley-Hamilton theorem.

Module II: Single Variable Calculus (5L)

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Concept of sequence and series, Power series; Taylor's series.

Module III: Multivariable Calculus (Differentiation) (13L)
Function of several variables; Concept of limit, continuity and differentiability;Partial derivatives, Total derivative and its application; chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function; Jacobian; Maxima and minima of functions of two variables.

Module IV: Multivariable Calculus (Integration) (7L)
Double Integral, Triple Integral;Change of order in multiple integrals; Line Integral, Surface Integral, Volume Integral. Change of variables in multiple integrals.

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference Books:

1. Guruprasad, S. A text book of Engineering Mathematics-I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
6. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
7. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
8. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
9. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
10. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

Course Name: Professional Communication
Paper Code: HU101
Contact: 2:0:0
Total Contact Hours: 24
Credit: 2

Pre-requisites:	Basic (10+2) level of knowledge of English grammar, vocabulary reading and writing skills.
Course Objectives	The course aims to impart domain and industry-specific communication skills in a globalized context and to promote the understanding of business communication practices and cross cultural dynamics.
Course Outcomes:	By pursuing this course the students shall be able to
	1. Define, describe and classify the modalities and nuances of communication in a workplace context.
	2. Review, appraise and understand the modes, contexts and appropriacy of communicating across cultures and societies.
	3. Identify, interpret and demonstrate the basic formats, templates of business and official communication.
	4. Identify, compare and illustrate reading strategies and basic writing strategies.
	5.Interpret, analyze and evaluate semantic-structural, interpersonal and multicultural dynamics in business communication.

Course Content:

Module 1:
Verbal and Nonverbal communication 4 L

1. Definition, Relevance and Effective Usage
2. Components of Verbal Communication: Written and Oral Communication
3. Components of Non-verbal Communication: Kinesics, Proxemics, Chronemics, Haptics Paralanguage
4. Barriers to Effective Communication

Module 2:
Workplace Communication Essentials and Cross Cultural Communication 4L

1. Communication at the Workplace—Formal and Informal Situations
2. Language in Use—Jargon, Speech Acts/Language Functions, Syntactical and Grammatical Appropriacy
3. Cultural Contexts in Global Business: High Context and Low Context Cultures
4. Understanding Cultural Nuances and Stereotyping
5. Achieving Culturally Neutral Communication in Speech and Writing

Module 3: 4L
Reading Strategies and Basic Writing Skills

Reading: Purposes and Nature of Reading
Reading Sub-Skills—Skimming, Scanning, Intensive Reading
Reading General and Business Texts(Reading for Comprehension and Detailed Understanding)
Basic Writing Skills—Paragraph and Essay writing, writing technical documents
1. Writing Technicalities—Paragraphing, Sentence Structure and Punctuation

Module 4: 4L
Report Writing
1. Nature and Function of Reports
2. Types of Reports
3. Researching for a Business Report
4. Format, Language and Style
5. Report Documentation

Module 5:
Employment Communication
a. Writing Business Letters—(Enquiry,Order, Sales,Complaint, Adjustment, Job Application, Offer) **2L**

b. Creating an Employee Profile-- Preparing a CV or Résumé.
Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile) **2L**
c. Writing Other Interoffice Correspondence--E-mails: types, convention, and etiquette,
Memo, Notices and Circulars **2L**
d. Preparing Meeting Documentation—Drafting Notice and Agenda of Meetings, Preparing Minutes of Meetings. **2L**

References :-

1. Meenakshi Raman and Sangeetha Sharma. *Technical Communication*. 3rd edition. New Delhi: Oxford University Press, 2015.
1. Mark Ibbotson. *Cambridge English for Engineering*. Cambridge: Cambridge University Press, 2008.
2. Mark Ibbotson. *Professional English in Use: Engineering*. Cambridge: Cambridge UP, 2009.
3. Lesikar et al. *Business Communication: Connecting in a Digital World*. New Delhi: Tata McGraw-Hill, 2014.
4. John Seeley. *Writing Reports*. Oxford: Oxford University Press, 2002.
5. Judith Leigh. *CVs and Job Applications*. Oxford: Oxford University Press, 2002.
6. Judith Leigh. *Organizing and Participating in Meetings*. Oxford: Oxford University Press, 2002.
7. Michael Swan. *Practical English Usage*. Oxford: OUP, 1980.
8. Pickett, Laster and Staples. *Technical English: Writing, Reading & Speaking.* 8th ed. London: Longman, 2001.
10. Diana Booher. *E-writing: 21st Century Tools for Effective Communication*.

Links:-

1. Purdue University's Online Writing Lab (OWL)- https://owl.purdue.edu/
2. Business English Pod- https://www.businessenglishpod.com/

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO.1	-	-	-	-	-	2	1	1	2	3	-	2
CO.2	-	-	-	-	-	1	1	2	2	3	-	3
CO.3	-	-	-	-	-	3	3	1	1	3	2	3
CO.4	-	-	-	-	-	3	3	1	-	3	-	3
CO.5						2	2	2	2	3	-	3

Course Name: Values and Ethics
Course Code: HU102
Contacts: 2:0:0
Total Contact Hours: 24
Credit: 2
Prerequisite: None

Course Outcomes:

CO 1	Understand the significance of values, various approaches to ethics and its applications in life and profession.
CO2	Able to distinguish Self and the Body, to understand Harmony in the Self
CO3	To identify and eradicate environmental concerns through technology
CO4	Demonstrate work ethics and analyse business strategies
CO5	rstand gender terminologies and to identify gender issues

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**2**
CO2	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	**2**	**-**	**-**
CO3	**-**	**3**	**3**	**-**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**2**
CO4	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**-**
CO5	**-**	**3**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**2**	**-**	**2**

Module: 1 Introduction: (4L)

Definition of Ethics; Approaches to Ethics: Psychological, Philosophical, and Social

Types of values-Social, Psychological, Aesthetic, Spiritual, and Organizational

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.

Module 2: Universal Human Harmony. (4L)

Basic Human Aspirations, Happiness and Prosperity, Self-Exploration, Self and the Body

Understanding the harmony in the Nature.

Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature.

Values Crisis in contemporary society Nature of values: Value Spectrum of a good life (Maslow's Pyramid)

Module: 3 Ethical Concerns: (6L)

Renewable Energy Resources, Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics

Rapid Technological growth and depletion of resources, Reports of the Club of Rome.

Problems of Technology transfer- Technology assessment impact analysis -Human Centered Technology.

Module: 4 Ethics of Profession: **(4L)**

Work Ethics and Work Values, Business Ethics, Human values in organizations:

Social and ethical responsibilities of Technologists. Codes of professional ethics.

Types of Ethical issues - Internal Ethics of Business –
Whistle Blowing
Impact of Ethics on Business Policies and Strategies – Ethical Leadership – Characteristics

Module: 5 Self Development AND Gender Awareness (6L)

Definition of Gender, Basic Gender Concepts and Terminology, Exploring Attitudes towards Gender, Social Construction of Gender

Gender Roles and Relations, Types of Gender Roles, Gender Roles and Relationships Matrix, Gender-based Division and Valuation of Labour. Gender Development Issues, Identifying Gender Issues

Text Books:

1. Beneria, Lourdes. (2004). Gender, Development, and Globalization: Economics as if All People Mattered. Roultedge Press. (GDGE)
2. Molyneux and Razavi. (2002). Gender Justice, Development and Rights. Oxford University Press (GJDR or WGD)
3. Visvanathan, Duggan,Wiegersma and Nisonoff. (2011).
4. The Women, Gender and Development Reader. 2nd Edition. Zed Press (WGD)
5. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)
6. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
7. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Course Name: Constitution of India
Course Code: HU103
Contacts: 2:0:0
Total Contact Hours: 24
Credit: 0

Prerequisite: None

Course Outcomes:
On completion of the course students will be able to
CO1: Identify and explore the basic features and modalities of Indian constitution.
CO2: Differentiate and relate the functioning of Indian parliamentary system at the centre and state level.
CO3: Differentiate the various aspects of Indian Legal System and its related bodies.

Course Content
Module 1: Introduction: 4L
"Constitution"- Historical Background of the Constituent Assembly, Indian Constitution and its Salient Features, the Preamble of the Constitution.

Module 2: Fundamental Rights, Fundamental Duties, Directive Principles of State Policy: 8L
The Right to Equality
The Right to Freedom: I (Article 19)
The Right to Freedom: II (Articles 20, 21 and 22)The Right against Exploitation
The Right to freedom of ReligionCultural and Educational rights The Right to Property
The Right to Constitutional RemediesThe Directive Principles Fundamental Duties

Module 3: Union Government and its Administration 6L
Structure of the Indian Union, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government
– Constitutional Scheme in India.

Module 4: The Machinery of Government in the State 6L
Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the PrimeMinister, Judiciary – The Independence of the Supreme Court, Appointment of Judges
State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Text / Reference Books:
Indian Constitution by D.D.Basu, The Publisher, LexisNexis
Constitution of India by Subhas C Kasyap, Vitasta Publishing
The Constitution of India, P.M Bakshi, Universal Law Publishing Co.Ltd, New Delhi, 2003.
Indian Constitution Text Book - Avasthi, Avasthi,Publisher: LAKSHMI NARAIN AGARWAL

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	2	-	2	-	3		1	3	3
CO2	3	2		1	-	1	-	2	2	3	3	3
CO3	3	-	1		-	3	-	2		1	3	3

Course Name: PROGRAMMING FOR PROBLEM SOLVING LAB
Course Code: DS191
Contact Hours: 3L/Week
Total Contact Hours: 36
Credits: 1.5

Course Outcomes	Name of Course Outcomes
CO1	**To identify the working of different operating systems like DOS, Windows, Linux**
CO2	**To express programs in C language**
CO3	**To implement programs connecting decision structures, loops**
CO4	**To experiment with user defined functions to solve real time problems**
CO5	**To write C programs using Pointers to access arrays, strings, functions, structures and files**

CO-PO-PSO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2						2	3	2	3	3
CO2	2	2	3	3	3							3	2	2	3
CO3	2	3	2	2	2							3	2	3	2
CO4	3	2	2	3	3							2	2	2	2
CO5	2	2	2	1	1						2	3	3	3	3

Course Content:

Module-1: Familiarization with some basic commands of DOS and Linux. File handling and Directory structures, file permissions, creating and editing simple C program in different editor and IDE, compilation and execution of C program. Introduction to Code block.

Module-2: Problem based on

a. Basic data types
b. Different arithmetic operators.
c. Print f( ) and scan f( ) functions.

Module-3: Problem based on conditional statements using

a. if-else statements
b. different relational operators
c. different logical operators

Module-4: Problem based on

a. **for** loop
b. **while** loop
c. **do-while** loop

Module-5: Problem based on

a. How to write a menu driven program using switch-case statement
b. How to write a function and passing values to a function
c. How to write a recursive function.

Module-6: Problem based on

a. How to use array (both I-Dand2-D).
b. How to pass an array to a function.

Module-7: Problem based on manipulation of strings in different way.

Module-8: Problem based on

a. How to handle compound variables in C
b. How to handle file in C
c. How to use command line argument in C

Textbook:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. KanetkarY.-LetusC,BPBPublication,15th Edition

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition

Course Name: ENGINEERING CHEMISTRY LAB
Paper Code: CH (DS)191
Total Contact Hours: 24
Credit: 1
Prerequisites: 10+2

Course Objective

- Study the basic principles of pH meter and conductivity meter for different applications
- Analysis of water for its various parameters & its significance in industries
- Learn to synthesis Polymeric materials and drugs
- Study the various reactions in homogeneous and heterogeneous medium

Course Outcome

CH191.1: Able to operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.
CH191.2: Able to analyse and determine the composition and physical property of liquid and solid samples when working as an individual and also as a team member
CH191.3: Able to analyse different parameters of water considering environmental issues
CH191.4: Able to synthesize drug and sustainable polymer materials.
CH191.5: Capable to design innovative experiments applying the fundamentals of modern chemistry

CO-PO Mapping

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	1	3	1	-	2	3	-	-	-	-	1
2	2	2	1	1	-	1	-	-	-	1	-	1
3	-	-	-	-	-	-	-	-	3	3	2	2
4	2	1	2	2	-	-	1	-	-	-	-	2
5	3	3	3	3	1	1	1	1	-	-	2	2

COURSE CONTENT

1. Synthesis of Silver Nanoparticles doped organic thin film for organic transistors.
2. Preparation of Si-nano crystals for future memory devices.
3. Determination of the concentration of the electrolyte through conductance measurement.
4. Green Synthesis of ZnO based Polymer Nano composites.

5. Determination of the concentration of the electrolyte through pH measurement.
6. Determination of water quality measurement techniques.
7. Isolation of graphene from dead dry batteries and their use for temporary soldering.
8. Synthesis of polymers for electrical devices and PCBs.
9. Determination of Partition Coefficient of acetic acid between two immiscible liquids.
10. Computational optimization of molecular geometry
11. Drug design and synthesis
12. Rheological properties of the Newtonian fluids
13. Innovative Experiments

Paper Name: Professional Communication Lab
Paper Code: HU191
Contact: (0:0:2)
Total Contact Hours: 26
Credit: 1

Pre requisites: Basic knowledge of LSRW skills.

Course Objectives: To train the students in acquiring interpersonal communication skills by focussing on language skill acquisition techniques and error feedback.

Course Outcome:
By pursuing this course the students will be able to:
CO1: Recognize, identify and express advanced skills of Technical Communication in English through Language Laboratory.
CO2: Understand, categorize, differentiate and infer listening, speaking, reading and writing skills in societal and professional life.
CO3: Articulate and present the skills necessary to be a competent Interpersonal communicator.
CO4: Deconstruct, appraise and critique communication behaviours.
CO5: Adapt, negotiate and facilitate with multifarious socio-economical and professional arenas with effective communication and interpersonal skills.

Course Contents:

Module 1: Introduction to the Language Lab
a. The Need for a Language Laboratory
b. Tasks in the Lab
c. Writing a Laboratory Note Book

Module 2: Active Listening
a. What is Active Listening?
b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c. Listening in Business Telephony

Module 3: Speaking
a. Speaking—Accuracy and Fluency Parameters
b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation
c. Fluency-focussed activities—JAM, Conversational Role Plays, Speaking using Picture/Audio Visual inputs
d. Accuracy-focussed activities—Identifying Minimal Pairs, Sound Mazes, Open and Closed Pair Drilling, Student Recordings (using software)
e. Group Discussion: Principles and Practice
f. Giving a Presentation—Learning Presentation Basics and Giving Micro Presentations

Module 4: Lab Project Work
a. Writing a Book Review
b. Writing a Film Review
c. Scripting a Short Presentation (2 minutes)
d. Making a short video CV (1-2 minutes)

References:

1.IIT Mumbai**, Preparatory Course in English** syllabus
2. IIT Mumbai, **Introduction to Linguistics** syllabus
3. Sasikumar et al. *A Course in Listening and Speaking*. New Delhi: Foundation Books, 2005.
4. Tony Lynch, *Study Listening*. Cambridge: Cambridge UP, 2004.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	2	-	-	1	1	-	2	3	-	2
CO2	-	-	2	2	-	3	3	-	2	3	-	3
CO3	-	-	2	2	-	3	3	2	2	3	-	3
CO4	-	-	-	-	-	3	3	2	2	3	-	3
CO5	-	-	2	2	-	3	3	2	2	3	-	3

Course name: Workshop and Manufacturing Practices Lab
Course code: ME(DS)191
Contact: 0:0:3
Credits: 1.5

Prerequisite: Physics & Mathematics (10+2 Level)

CO1: Gain basic knowledge of Workshop Practice and Safety useful for our daily living.
CO2: Understand the use of Instruments of a pattern shop like Hand Saw, Jack Plain, Chisels etc.
CO3: Apply and performing operations like such as Marking, Cutting etc used in manufacturing processes.
CO4: Analyse the various operations in the Fitting Shop using Hack Saw, various files, Scriber, etc to understand the concept of tolerances applicable in all kind of manufacturing.
CO5: Get hands on practice of in Welding and apply various machining processes which give a lot of confidence to manufacture physical prototypes in project works.

Course Content:

3P

(i) Theoretical discussions:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. Fitting operations & power tools
3. Carpentry
4. Welding (arc welding & gas welding), brazing
5. Electrical & Electronics
6. Metal casting
7. CNC machining, Additive manufacturing, 3D Printing
8. Plastic moulding & Glass Cutting

(ii) Workshop Practice:

At least 6 modules should be covered

Module 1 - Machine shop **6P**

Typical jobs that may be made in this practice module:

i. To make a pin from a mild steel rod in a lathe.
ii. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

Module 2 - Fitting shop 6P

Typical jobs that may be made in this practice module: To make a Gauge from MS plate.

Module 3 – Carpentry Shop 6P

Typical jobs that may be made in this practice module: To make wooden joints and/or a pattern or like.

Module 4 - Welding & Soldering shop 6P

Typical jobs that may be made in this practice module:

i. Arc Welding: To join two thick (approx 5mm) MS plates by manual metal arc welding.
ii. Gas Welding: To join two thin mild steel plates or sheets by gas welding.

iii. House wiring, soft Soldering

Module 5 – Smithy & Casting 6P

Typical jobs that may be made in this practice module:

i. A simple job of making a square rod from a round bar or similar.
ii. One/ two green sand moulds to prepare, and a casting be demonstrated.

Module 6 – CNC Machining & Laser Cutting 6P

Typical jobs that may be made in this practice module:

i. At least one sample shape on mild steel plate should be made using CNC Milling / CNC Lathe Machine
ii. At least one sample shape on glass should be made using laser cutting machine.

Module 7 – 3D Printing 6P

i. Exposure to a 3D printing machine,
ii. 3D printing of at least one sample model using available materials.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., ―Elements of Workshop Technology‖, Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Rao P.N., ―Manufacturing Technology‖, Vol. I and Vol. II, Tata McGrawHill House, 2017.

Reference Books:

1. Gowri P., Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Roy A. Lindberg, ―Processes and Materials of Manufacture‖, 4th edition, Prentice Hall India, 1998.
3. Kalpakjian S. and Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
4. Manufacturing Science by A. Ghosh and A.K. Mallick, Wiley Eastern.
5. Principles of Metal Cutting/Principles of Machine Tools by G.C. Sen and A. Bhattacharya, New Central Book Agency, Kolkata.

CO-PO/PSO Mapping:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	3						2		2	2					
CO 2	3						2		2	2					
CO 3	3						2		2	2			2		2
CO 4	3						2		2	2			2		2
CO 5	3	2	2				2		2	2					

1st Year 2nd Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
					L	T	P	Total	
A. THEORY									
1	ENGG	Major	DS201	Data Structures	3	0	0	3	3
2	ENGG	Minor	EC(DS)201	Basic Electrical and Electronics Engineering	3	0	0	3	3
3	SCI	Multidisciplinary	PH(DS)201	Engineering Physics	3	0	0	3	3
4	SCI	Multidisciplinary	M(DS)201	Discrete Mathematics	3	0	0	3	3
5	HUM	Value added course	HU204	Environmental Science	2	0	0	2	2
6	HUM	Value added course	HU205	Indian Knowledge System	1	0	0	1	1
B. PRACTICAL									
1	ENGG	Major	DS291	Data Structures Lab	0	0	3	3	1.5
2	ENGG	Minor	EE(DS)291	Basic Electrical and Electronics Engineering Lab	0	0	3	3	1.5
3	HUM	Ability Enhancement Course	HU292	Design Thinking Lab	0	0	2	2	1
4	SCI	Skill Enhancement Course	PH(DS)291	Engineering Physics Lab	0	0	3	3	1.5
5	ENGG	Skill Enhancement Course	ME(DS)291	Engineering Graphics & Design Lab	0	0	3	3	1.5

Total of Theory, Practical	29	22

Course Name: DATA STRUCTURES
Course Code: DS201
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Course Objectives:

1. **To learn the basics of abstract data types.**
2. **To learn the principles of linear and nonlinear data structures.**
3. **To build an application using sorting and searching.**

Course Outcomes	Name of Course Outcomes
DS201.1	To identify how the choices of data structure & algorithm methods impact the performance of program.
DS201.2	To express problems based upon different data structure for writing programs.
DS201.3	To implement programs using appropriate data structure & algorithmic methods for solving problems.
DS201.4	To explain the computational efficiency of the principal algorithms for sorting, searching, and hashing.
DS201.5	To write programs using dynamic and static data structures and building applications for real world problems.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS201.1	3	2		2	3						1	3	1	1	1
DS201.2	3	2	2	2	2							2	3	2	2
DS201.3	2	3	3	2	3						1	2	3	3	3
DS201.4	2	2	2	3	1							1	2	1	2
DS201.5	2	3	3	3	2						1	2	3	3	3
	2.40	**2.40**	**2.50**	**2.40**	**2.20**							**2.00**	**2.40**	**2.00**	**2.20**

Course Content:

Module 1: Introduction [4L]

Concepts of data and information; Concept of Abstract Data Type, Data Structure and Data Type. Classification of Data Structures- Primitive and Non-Primitive Data Structure, Linear and Non-Linear Data Structure. Need of Data Structures. (1L)
Concept of algorithms and programs, Different methods of representing algorithm; Algorithm analysis, time and space analysis of algorithms – Asymptotic notations like Big Oh (O), Small Oh(o), Big Omega(Ω), Small Omega(ω) and Theta(Θ) notation (definition and significance). (3L)

Module 2: Non-Restricted Linear Data Structure [9L]

List or Linear List: Definition and Example, List as ADT. Representation of Linear List- Sequential Representation and Linked Representation.
Array: Introduction to sequential representation, Linearization of multidimensional array. Application of array- representation of polynomial using array, Representation of Sparse matrix using array.
Linked List: Introduction to linked representation, Implementation of different types of linked list- Singly linked list, Doubly linked list, Circular linked list, Circular Doubly Linked List, Application of Linked list- Representation of polynomial.

Module 3: Restricted Linear Data Structure [6L]

Stack: Definition of Stack, implementations of stack using array and linked list, Applications of stack- infix to postfix conversion, Postfix Evaluation
Recursion: Principles of recursion - use of stack, tail recursion. Tower of Hanoi using recursion.
Queue: Definition of Queue; Implementation of queue using array-physical, linear and circular model; Implementation of queue using linked list.
Dequeue - Definition and different types of dequeue.

Module 4: Nonlinear Data structures [9L]

Trees and Binary Tree:
Basic terminologies; Definition of tree and binary tree. Difference between tree and binary tree, Representationof binary tree (using array and linked list)
Binary tree traversal (pre-, in-, post- order); Threaded binary tree- definition, insertion and deletion algorithm;Binary search tree- Definition, insertion, deletion, searching algorithm;
Height balanced binary tree: AVL tree- definition, insertion and deletion with examples only.
m –Way Search Tree: B Tree – Definition, insertion and deletion with examples only; B+ Tree – Definition,insertion and deletion with examples only.
Heap: Definition (min heap and max heap), creation, insertion and deletion algorithm. Application of heap(priority queue and sorting).
Graphs: Definition and representation (adjacency matrix, incidence matrix and adjacency list).
Graph traversal– Depth-first search (DFS), Breadth-first search (BFS) - concepts of edges used in DFS and BFS(tree-edge, back-edge, cross-edge, and forward-edge)**.**

Module 5: Sorting and Searching [8L]

Sorting Algorithms: Definition and need of sorting, different types of sorting algorithm (internal, external, stable, in-place, comparison based); Factors affecting sorting Methods, Bubble sort, Insertion sort, Selection sort, Quick sort, Merge sort, Radix sort – algorithm with analysis (time complexity)
Searching: Factors affecting searching Methods; Sequential search –algorithm with analysis (time complexity); improvement using sentinel.

Binary search and Interpolation Search algorithm with analysis (time complexity)
Hashing: Introduction and purpose of Hashing and Hash functions (division, folding and mid-square), Collisionresolution techniques.

Text book:

1. Data Structures Through 'C' Language by Samiran Chattopadhyay, Debabrata Ghosh Dastidar, MatanginiChattopadhyay, Edition: 2001, BPB Publications
2. Fundamentals of Data Structures of C by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed 2nd Edition,Universities Press

Reference Books:

1. Data Structures, Algorithms, and Software Principles in C by Thomas A. Standish, 1 Edition, Pearson.
2. Data Structures by S. Lipschutz, Special Indian Edition, Tata McGraw Hill Education (India) PrivateLimited
3. Data Structures and Program Design in C by Robert L. Kruse, Bruce P. Leung 2nd Edition, Pearson
4. Data Structures in C by Aaron M. Tenenbaum, 1St Edition, Pearson

Paper Name: BASICS ELECTRICAL AND ELECTRONICS ENGINEERING
Paper Code: EE(DS)201
Category: -Minor
L-T-P: 3-0-0
Credit: 3
Total Lecture: 36

CO	Statement
CO1	Apply fundamental concepts and circuit laws to solve simple DC electric circuits
CO2	To solve simple ac circuits in steady state
CO3	Impart the knowledge of Basic Electronics Devices and ICs.
CO4	Analyze the simple electronics circuits

MODULE 1: Elementary Concepts of Electric Circuits 6L

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with independent sources only (Steady state)
Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

MODULE 2: Electrical machine **8L**

Transformer: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.
DC Machines: Brief idea on constructional features, classifications, working principle of both motor and generator. Simple problems on Voltage equation.

MODULE 3:
Fundamentals of Semiconductor Devices: 6L
Introduction to Semiconductor: Concept of energy band diagram; Comparison among metal, insulator, semiconductor; Semiconductors-classifications and Fermi energy level; Charge neutrality and Mass-Action law in semiconductor; Current flow in semiconductor due to drift & diffusion process; Einstein relation.

MODULE 4: PN Junction Diode: 4L
Principle of operation; V-I characteristics; principle of avalanche & Zener breakdown; Junction resistances and capacitances; V-I characteristics of Zener diode.

MODULE 5: Bipolar Junction Transistors: 4L
PNP and NPN structures; Principle of operation; Current gains in CE, CB and CC mode; input and output characteristics; Biasing & Stability Analysis-Concept of Fixed Bias, Collector to base Bias & voltage divider bias.

MODULE 6: Introduction to IC: 8L
Integrated circuit-Basic idea, classifications, advantages, disadvantages; OPAMP(IC741)-Pin configuration and equivalent circuit; Characteristics of OPAMP(IC741); Inverting & Non-Inverting Amplifier; Adder, Subtractor, Differentiator & Integrator Circuit.

Textbooks:

A Textbook of Electrical Technology - Volume I (Basic Electrical Engineering) & Volume II (Ac & DC Machines)-B. L Theraja & A.K. Teraja, S. Chad,23rd Edition, 1959
D. Chattopadhyay, P.C Rakshit, "Electronics Fundamentals and Applications", New Age International (P) Limited Publishers, Senenth Edition,2006
Basic Electrical & Electronics Engineering by J.B. Gupta , S.K. Kataria & Sons,2013
Basic Electrical and Electronics Engineering-I by Abhijit Chakrabarti and Sudip Debnath, McGraw Hill, 2015
M.S.Sukhija andT.K.Nagsarkar,Basic Electrical and Electronics Engineering, Oxford University Press,2012.
DP Kothari and IJ Nagrath,"Basic Electrical & Electronics Engineering", Tata McGraw Hill,2020.

ReferenceBooks

DC Kulshreshtha,"Basic Electrical Engineering",TataMcGrawHill,2010.
T.K. Nagsarkar, M.S.Sukhija,"BasicElectricalEngineering",OxfordHigherEducation.
Hughes,"Electrical and ElectronicTechnology",Pearson Education".
Parker and Smith,"Problems in Electrical Engineering",CBS Publishers and Distributors.
Anant Agarwal, Jeffrey Lang, Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann Publishers, 2005.
Bernard Grob,Basic Electronics,McGrawHill.
Chinmoy Saha, Arindham Halder and Debarati Ganguly, Basic Electronics-Principles and Applications, Cambridge University Press, 2018.

CO-PO Course Articulation Matrix Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	-	-	-	-	-	-	2	2
CO2	3	3	2	1	-	-	-	-	-	-	2	2
CO3	3	2	2	1	-	-	-	-	-	-	1	2
CO4	2	3	2	1	-	-	-	-	-	-	2	1

Course Name: Engineering Physics
Course Code: PH(DS)201
Contact: (3:0:0)
Total Contact Hours: 36
Credits: 3
Prerequisites: Knowledge of Physics up to 12th standard.

Course Objectives:
The aim of courses in Physic-I is to provide adequate exposure and develop insight about the basic principles of physical sciences and its practical aspects which would help engineers to learn underlying principles of various tools and techniques they use in core engineering and related industrial applications. The course would also inculcate innovative mindsets of the students and can create awareness of the vital role played by science and engineering in the development of new technologies.

Course Outcomes (COs):

After attending the course students' should be able to

CO	Description
CO1	explain basic principles of laser, optical fiber and holography.
CO2	understand the properties of Nano material and semiconductor.
CO3	analyze different crystallographic structures according to their co-ordination number and packing factors.
CO4	analyze the structure, function and characteristics of different storage devices.
CO5	justify the need of a quantum mechanics as remedy to overcome limitations imposed by classical physics.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	--	--	--	--	--	--	--	2
CO2	3	3	2	2	--	--	--	--	--	--	--	2
CO3	3	3	2	2	--	--	--	--	--	--	--	1
CO4	3	2	2	2	--	--	--	--	--	--	--	2
CO5	3	3	3	2	2	--	--	--	--	--	--	1

Course Content:

Module 1 (12L)
Modern Optics
1.01- Laser: Concepts of various emission and absorption processes, Einstein A and B coefficients and equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser, related numerical problems. 6L
1.02-Fibre optics-Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. 3L
1.03-Holography-Theory of holography, viewing of holography, applications 3L

Module 2 (6L)
Solid State Physics
2.01 Crystal Structure: Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices –Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. 3L
2.02 Semiconductor: Physics of semiconductors, electrons and holes, metal, insulator and semiconductor,

intrinsic and extrinsic semiconductor, p-n junction. 3L

Module 3 (8L)
Quantum Mechanics
3.01 Quantum Theory: Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: photoelectric and Compton Effect; no derivation required, origin of modified and unmodified lines), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment, related numerical problems. 4L
3.02 Quantum Mechanics 1: Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions-Qualitative discussion; uncertainty principle, relevant numerical problems, Introduction of Schrödinger wave equation (only statement).
4L

Module 4 (4L)
Physics of Nanomaterials
Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, graphene, electronic, environment, medical).

Module 5 (6L)
Storage and display devices
Different storage and display devices-Magnetic storage materials, Hard disc (examples related to computers compared with semiconductor storage viz. Pendrive), Operation and application of CRT, CRO, Liquid crystal display (LCD), LED, OLED, Plasma display, Thin film transistor display).

Recommended Text Books for Physics I:

Text Books:
1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3)-C. L. Arora (S. Chand Publishers).
2. Engineering Physics (Vol. 1, Vol. 2)-S.P. Kuila (S. Chand Publishers).
3. Perspective & Concept of Modern Physics -Arthur Baiser (Publisher: MaGrawhill)
4. Principles of engineering physics – Md. N Khan and S Panigrahi (Cambridge University Press).
5. Concepts of Modern Engineering Physics-A. S. Vasudeva. (S. Chand Publishers)
6. Engineering Physics (Vol. 1, Vol. 2)-S.P. Kuila (S. Chand Publishers).
7. Physics Volume 1&2 - Haliday, Resnick & Krane, Publisher: Wiley India).
8. Engineering Physics-B. K. Pandey And S. Chaturvedi (Publisher: Cengage Learning, New Delhi).

Recommended Reference Books for Physics I:

Modern Optics:
1. A text book of Light-Brijlal & Subhramanium, (S. Chand publishers).
2. Optics-Ajay Ghatak (TMH)

Solid State Physics:
1. Solid state physics- S. O. Pillai.
2. Introduction to solid state physics-Kittel (TMH).

Quantum Mechanics:
1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House).
2. Quantum mechanics -A.K. Ghatak and S Lokenathan

Physics of Nanomaterials
1. Introduction to Nanotechnology, B.K. Parthasarathy.
2. Introduction to Nanoscience and Nanotechnology, An Indian Adaptation-Charles P. Poole, Jr., Frank J. Owens.

Storage and display devices
1. Optics-B.D. Gupta (Books and Allied Pvt. Ltd.).

2. Solid state physics, solid state devices and electronics by C. M. Kachhava.

Course Name: Discrete Mathematics
Course Code: M(DS) 201
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites:

The students to whom this course will be offered must have the concept of (10+2) standard Mathematics.

Course Objectives:

The objective of this course is to disseminate the prospective engineers with the knowledge of Abstract Algebra, Combinatorics, Recurrence Relation, Propositional Logic, Number Theory and Graph Theory.

Course Outcome(s):

On successful completion of the learning sessions of the course, the learner will be able to:

CO1: Recall the properties of abstract algebra, recurrence relation, propositional logic, number theory and graph theory.

CO2: Explain the theoretical working of the concepts of abstract algebra, recurrence relation, propositional logic, number theory and graph theory.

CO3: Apply the concepts of abstract algebra, recurrence relation, number theory, propositional logic and algorithms of graph theory in Computer Science.

CO4: Examine the Poset, Lattices, algebraic structures and graphs using the underlying concepts.

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1
CO3	3	3	2	1	-	-	-	-	-	-	-	2
CO4	3	3	3	2	-	-	-	-	-	-	-	2
M(DS) 201	**3**	**2.5**	**2**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.5**

Weightage Values: Strongly mapped: ‘3’, Moderately mapped: ‘2’, Weakly mapped: ‘1’, Not mapped: ’-‘.

Course Content:

Module-I: Set Theory [11L]

Posets& Lattices: [6L]

Relation: Types of Relations, Properties of Binary Relation, Equivalence Relation, Partial Ordering Relation and Posets, Lattices.

Combinatorics: [2L]

Principle of Inclusion Exclusion, Pigeon Hole Principle.

Generating Functions and Recurrence Relations: [3L]

Generating functions, Recurrence relations: Formulation of different counting problems in terms of recurrence relations, Solution of recurrence relations with constant coefficients by Generating functions method.

Module-II: Propositional Logic[5L]

Basics of Boolean Logic, Idea of Propositional Logic, well-formed formula, Logical Connectives, Truth tables, Tautology, Contradiction, Algebra of proposition, Logical Equivalence, Normal Forms: Disjunctive Normal Forms (DNF) and Conjunctive Normal Forms (CNF).

Module-III: Number Theory [4L]

Well-Ordering Principle, Divisibility theory and properties of Divisibility, Fundamental theorem of Arithmetic, Prime and Composite Numbers, Greatest Common Divisor and Euclidean Algorithm, Congruence, Residue Classes.

Module-IV: Algebraic Structures [8L]

Concepts of Groups, Subgroups and Order, Cyclic Groups, Cosets, Lagrange's theorem, Normal Subgroups, Permutation Groups and Symmetric Groups, Definition of Ring and Field.

Module-V: Graph Theory [8L]

Graph theory, Theorems (statement only), Digraphs, Weighted Graph, Walk, Path, Circuit, Connected and Disconnected Graph, Bipartite Graph, Complement of a Graph, Regular Graph, Complete Graph, Adjacency and Incidence matrices of a graph (digraph), Dijkstra's algorithm.

Tree, Binary Tree, Theorems on Tree (statement only), Spanning Tree, Minimal Spanning Tree, Kruskal's Algorithm, Prim's Algorithm.

Project Domains:

1. Study of physical processes through Graph theory.
2. Application of Propositional Logic in real world engineering problems.
3. Application of Abstract Algebra in engineering problems.

Text Books:

1. Deo, N.,Graph Theory with Applications to Engineering and Computer Science, Prentice Hall.
2. Mapa, S. K.,Higher Algebra: Abstract and Linear, Levant, 2011.
3. Chakraborty, S. K. and Sarkar,B. K.,Discrete Mathematics, OXFORD University Press.
4. Rosen, K. H.,Discrete Mathematics and its Applications, Tata McGraw – Hill.

Reference Books:

1. Grewal, B. S.,Higher Engineering Mathematics, Khanna Pub.
2. Kreyzig, E.,Advanced Engineering Mathematics, John Wiley and Sons.
3. Sharma, J.K.,Discrete Mathematics, Macmillan.
4. Liu, C. L. and Mohapatra, D. P.,Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition, Tata McGraw – Hill.
5. Tremblay, J. P. and Manohar, R.,Discrete Mathematical Structure and It's Application to Computer Science, TMG Edition, TataMcgraw-Hill.

Course Name: Environmental Science
Course Code: HU204
Contact: 2:0:0
Total Contact Hours: 24
Credits: 2

Course Objective(s)

This course will enable the students to,

- Realize the importance of environment and its resources.
- Apply the fundamental knowledge of science and engineering to assess environmental and health risk.
- Know about environmental laws and regulations to develop guidelines and procedures for health and safety issues.
- Solve scientific problem-solving related to air, water, land and noise pollution.

Module 1 - Resources and Ecosystem (6L)

3. **Resources (2L)**

   Types of resources, resistance to resources, Human resource, Population Growth models: Exponential Growth, logistic growth

4. **Ecosystem (3L)**

   Components of ecosystem, types of ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Food chain, Food web.

5. **Energy and Environment(1L)**

   Conventional energy sources, coal and petroleum, Green energy sources, solar energy, tidal energy, geothermal energy, biomass

Module 2 – Environmental Degradation (9L)

3. **Air Pollution and its impact on Environment (3L)**

   Air Pollutants, primary & secondary pollutants, Criteria pollutants, Smog, Photochemical smog and London smog, Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion.

4. **Water Pollution and its impact on Environment (3L)**

   Water Pollutants, Oxygen demanding wastes, heavy metals, BOD, COD, Eutrophication, Hardness, Alkalinity, TDS and Chloride, Heavy metal poisoning and toxicity.

5. **Land Pollution and its impact on Environment (2L)**

   Solid wastes, types of Solid Waste, Municipal Solid wastes, hazardous wastes, bio-medical wastes, E-wastes

6. **Noise Pollution and its impact on Environment (1L)**

   Types of noise, Noise frequency, Noise pressure, Noise intensity, Noise Threshold limit, Effect of noise pollution on human health.

Module 3 – Environmental Management (6L)

6. **Environmental Impact Assessment (1L)**

   Objectives of Environmental management, Components of Environmental Management, Environmental

Auditing, Environmental laws and Protection Acts of India

7. **Pollution Control and Treatment (2L)**

   Air Pollution controlling devices, Catalytic Converter, Electrostatic Precipitator, etc., Waste Water Treatment, Noise pollution control.

8. **Waste Management (3L)**

   Solid waste management, Open dumping, Land filling, incineration, composting, E-waste management, Biomedical Waste management.

Module 4 – Disaster Management (3L)

4. **Study of some important disasters (2L)**

   Natural and Man-made disasters, earthquakes, floods drought, landside, cyclones, volcanic eruptions, tsunami, Global climate change. Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

5. **Disaster management Techniques (1L)**

   Basic principles of disasters management, Disaster Management cycle, Disaster management policy, Awareness generation program

Course Name: Indian knowledge System
Course Code: HU205
Contact: 1:0:0
Total Contact Hours: 12
Credits: 1

Course Content:

Module – 1 (3L)
An overview of Indian Knowledge System (IKS): Importance of Ancient Knowledge - Definition of IKS - Classification framework of IKS - Unique aspects of IKS.
The Vedic corpus: Vedas and Vedangas - Distinctive features of Vedic life.
Indian philosophical systems: Different schools of philosophy.

Module – 2 (3L)
Salient features of the Indian numeral system - Importance of decimal representation - The discovery of zero and its importance - Unique approaches to represent numbers.
Highlights of Indian Astronomy: Historical development of astronomy in India

Module – 3 (3L)
Indian science and technology heritage - Metals and metalworking - Mining and ore extraction –Physical structures in India - Irrigation and water management - Dyes and painting technology - Surgical Techniques - Shipbuilding

Module – 4 (3L)
Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, Traditional Knowledge in agriculture, Traditional societies depend on it for their food and healthcare needs.

References:
1) Introduction to Indian knowledge system: concepts and applications-Mahadevan B.Bhat, Vinayak Rajat, Nagendra Pavana R.N.,PHI

2) Traditional Knowledge system in India, Amit Jha, Atlantic Publishers

3) S. N. Sen and K. S. Shukla, *History of Astronomy in India*, Indian National Science Academy, 2nd edition, New Delhi, 2000

Course Name: DATA STRUCTURES LAB
Course Code: DS291
Contact (Periods/Week) :3L/Week
Total Contact Hours: 36
Credits: 1.5

Course Outcomes	Name of Course Outcomes
DS291.1	To identify the appropriate data structure as applied to specified problem definition.
DS291.2	To summarize operations like searching, insertion, deletion, traversing mechanism used on various data structures.
DS291.3	To implement practical knowledge of data structures on the applications.
DS291.4	To illustrate how to store, manipulate and arrange data in an efficient manner.
DS291.5	To write programs to access queue and stack using arrays and linked list, binary tree and binary search tree.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS291.1	3	3	3	2	3	-	-	-	-	-	-	2	1	1	1
DS291.2	3	2	2	3	3	-	-	-	-	-	3	2	3	2	2
DS291.3	2	3	3	-	2	-	-	-	-	-	-	2	3	3	3
DS291.4	2	2	1	3	2	-	-	-	-	-	2	3	2	1	2
DS291.5	2	2	3	1	2	-	-	-	-	-	-	3	3	3	3
	2.4	2.4	2.4	2.3	2.4	-	-	-	-	-	2.5	2.4	2.4	2	2.2

Course Content:

Module 1: Implementing Non-Restricted Linear Data Structure [2 Lab]
Problem based on Implementation of Non-Restricted Linear Data Structure like-Implementation of list as data structure using array.
Implementation of list as data structure using linked list of different types. Implementation of polynomial as data structure using array and linked list.Implementation of sparse matrix as data stricture using array.

Module 2: Implementing Restricted Linear Data Structure [3 Lab]
Problem based on Implementation of Restricted Linear Data Structure like- Implementation of stack as data structure using array.
Implementation of stack as data structure using linked list.
Implementation of queue as data structure using array (physical, linear and circular model). Implementation of queue as data structure using linked list.
Converting infix to post-fix and evaluating post-fix expression using stack.Implementing Tower-of-Hanoi problem.

Module 3: Implementing Non-Linear Data Structure [2 Lab]

Problem based on Implementation of Non-Linear Data Structure like Implementation of Binary Tree as data structure using array and linked list.
Implementation of Binary Search Tree (BST) as data structure using linked list.

Implementation of Heap as data structure using array.
Implementation of Priority Queue as data structure using Heap.

Module 4: Implementing Sorting and Searching algorithm [5 Lab]
Problem based on Implementation of Sorting and Searching algorithm
Implementation of Bubble sort using appropriate data structure.
Implementation of Selection sort using appropriate data structure.
Implementation of Insertion sort using appropriate data structure. Implementation of Quick sort using appropriate data structure.
Implementation of Merge sort using appropriate data structure.
Implementation of Heap sort using appropriate data structure.
Implementation of Radix sort using appropriate data structure.
Implementation of Sequential Search using appropriate data structure.
Implementation of Binary Search using appropriate data structure.
Implementation of hashing with collision resolution using linear and quadratic probing.

Text books:

1. Data Structures Through 'C' Language by Samiran Chattopadhyay, Debabrata Ghosh Dastidar, MatanginiChattopadhyay, Edition: 2001, BPB Publications.
2. Fundamentals of Data Structures of C by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed 2nd Edition,Universities Press.

Reference books:

1. Data Structures, Algorithms, and Software Principles in C by Thomas A. Standish, 1 Edition, Pearson.
2. Data Structures by S. Lipschutz, Special Indian Edition, Tata McGraw Hill Education (India) Private.
3. LimitedData Structures and Program Design In C by Robert L. Kruse, Bruce P. Leung 2nd Edition, Pearson.
4. Data Structures in C by Aaron M. Tenenbaum, 1St Edition, Pearson

Name: Basics Electrical and Electronics Engineering Laboratory
Paper Code: EE(DS)291
Category: -Minor
L-T-P: 0-3-0
Credit: 1.5
Total Lecture: 36

CO	Statement
CO1	To Analyze a given network by applying KVL and KCL.
CO2	To Examine the Operation of DC Motor.
CO3	To Examine the Operation of Basic Electronics Devices and ICs.
CO4	To design simple electronics circuits.

List of Experiments: -

1. Familiarization with different passive and active electrical & electronic components.
2. Familiarization with different Electrical & Electronics Instruments.
3. Verification of KVL and KCL.
4. Forward and reversal of DC shunt motor.
5. Speed control of DC shunt motor.
6. Study of the P-N junction diode V-I characteristics (Forward & Reverse Bias).
7. Study of the Characteristics of Zener diode (Forward & Reverse Bias).
8. Study of the Input and Output characteristics of BJT in CE mode.
9. Determination of offset voltage, offset current & bias current of OPAMP(IC741).
10. Determination of CMRR and slew rate of OPAMP(IC741).
11. Determination of inverting and non-inverting gain of OPAMP(IC741).
12. Extramural Experiment.

Textbooks:

1. Handbook of Laboratory Experiments in Electronics Engineering Vol. 1, Author Name: A.M. Zungeru, J.M. Chuma, H.U. Ezea, and M. Mangwala, Publisher -Notion Press Electronic Devices and Circuit Theory by Robert Boylestad Louis Nashelsky,7th Edition, Prentice Hall
2. Experiments Manual for use with Grob's Basic Electronics 12th Edition by Wes Ponick, Publisher-McGraw Hill,2015
3. Laboratory Manual for 'Fundamentals of Electrical & Electronics Engineering': A handbook for Electrical & Electronics Engineering Students by Manoj Patil (Author),

Jyoti Kharade (Author), 2020
4. The Art of Electronics, Paul Horowitz, Winfield Hill,Cambridge University Press, 2015.
5. A Handbook of Circuit Math for Technical Engineers, Robert L. Libbey CRC Press, 05-Jun-1991

Reference Books

1. Basic Electrical and Electronics Engineering, Author:S. K. Bhattacharya, Publisher: Pearson Education India,2011
2. Practical Electrical Engineering
3. By Sergey N. Makarov, Reinhold Ludwig, Stephen J. Bitar, Publisher: Springer International Publishing, 2016
4. Electronics Lab Manual (Volume 2) By Navas, K. A. Publisher: PHI Learning Pvt. Ltd. 2018
5. Practical Electronics Handbook, Ian R. Sinclair and John Dunton, Sixth edition 2007, Published by Elsevier Ltd.

CO-PO Course Articulation Matrix Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	3	2	-	2	-	-	2	-	2	3
CO2	3	3	2	3	-	2	-	-	3	-	2	2
CO3	3	2	2	3	-	2	-	-	2	-	3	3
CO4	3	3	2	2	-	2	-	-	3	-	2	3

Course Name: Design Thinking Lab
Course Code: HU292
Contact: 0:0:2
Credits: 1

Course Content:

Module 1:
Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting. (**2L)**
Module 2:
Memory: process, Sensory memory, STM and LTM, Problems in retention, Memory enhancement techniques. (**4L)**
Module 3:
Emotions: Experience & Expression Understanding Emotions, Empathy, and Concept of Emotional Intelligence. (**2L)**
Module 4:
Basics of Design Thinking Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test. (**6L)**
Module 5:
Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving. (**4L)**
Module 6:
Prototyping & Testing -Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing. (**2L)**
Module-7:
Design thinking for strategic innovations Growth –Change- Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience -Value redefinition - Extreme Competition – Standardization —Strategy– Business Model design. (**4L)**

References:
1. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) second Edition, 2013.
2. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
3. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013
4. George, E, Dieter, Linda, C, Schmidt. (2017). Engineering Design, McGraw Hill publisher, 4th edition

Course Name: Engineering Physics Lab
Code: PH(DS)291
Contact Hours: 0:0:3
Credit: 1.5

Prerequisites: Knowledge of Physics up to 12th standard.

Course Objectives:
The aim of course is to provide adequate exposure and develop insight about the basic principles of physical sciences and its practical aspects which would help engineers to learn underlying principles of various tools and techniques they use in core engineering and related industrial applications. The course would also inculcate innovative mindsets of the students and can create awareness of the vital role played by science and engineering in the development of new technologies.

Course Outcomes (COs):

After attending the course students' will be able to

CO1: demonstrate experiments allied to their theoretical concepts

CO2: conduct experiments using LASER, Optical fiber.

CO3: participate as an individual, and as a member or leader in groups in laboratory sessions actively CO4 : analyze experimental data from graphical representations, and to communicate effectively them in Laboratory reports including innovative experiment.

CO5: Design solutions for real life challenges.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	3	--	--	--	--	--	--	--
CO2	2	3	2	3	3	--	--	--	--	--	--	--
CO3	2	3	2	3	3	--	--	--	--	--	--	--
CO4	2	2	3	2	3	--	--	--	--	--	--	--
CO5	2	2	3	2	3	--	--	--	--	--	--	--

Course Content:

General idea about Measurements and Errors (One Mandatory):

i) Error estimation using Slide calipers/ Screw-gauge/travelling microscope for one experiment.

Experiments on Classical Physics (Any 4 to be performed from the following experiments):

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of Young's moduli of different materials.
3. Determination of Rigidity moduli of different materials.
4. Determination of wavelength of light by Newton's ring method.
5. Determination of wavelength of light by Laser diffraction method.

6. Optical Fibre-numerical aperture, power loss.

Experiments on Quantum Physics (Any 2 to be performed from the following experiments):

7. Determination of Planck's constant using photoelectric cell.
8. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
9. Determination of Stefan's Constant.
10. Study of characteristics of solar cell.

Perform atleast one of the following experiments:

11. Calibration of an oscillator using Lissajous Figure.
12. Determination of specific charge of an electron (e/m) by J. J Thompson Method.

**In addition it is recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

Probable experiments beyond the syllabus:

1. Study of dispersive power of material of a prism.
2. Study of viscosity using Poiseuille's capillary flow method/using Stoke's law.
3. Determination of thermal conductivity of a bad/good conductor using Lees-Charlton / Searle apparatus.
4. Determination of the angle of optical rotation of a polar solution using polarimeter.
5. Any other experiment related to the theory.

Recommended Text Books for Engineering Physics Lab:

Waves & Oscillations:
1. Vibration, Waves and Acoustics- Chattopadhyay and Rakshit Classical & Modern

Optics:
2. A text book of Light- K.G. Mazumder & B.Ghosh (Book & Allied Publisher)

Quantum Mechanics-I
1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)

Solid State Physics:
1. Solid State Physics and Electronics-A. B. Gupta and Nurul Islam (Book & Allied Publisher)

Text Books:
1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)
2. Practical Physics by K.G. Mazumder (New Central Publishing)
3. Practical Physics by R. K. Kar (Book & Allied Publisher)

Course Name: Engineering Graphics & Design Lab
Course Code: ME(DS)291
Contact: 0:0:3
Credits: 1.5

Prerequisites: Basic knowledge of geometry

Course Outcomes: Upon successful completion of this course, the student will be able to:

CO1: Learn the basics of drafting

CO2: Understand the use of drafting tools which develops the fundamental skills of industrialdrawings.

CO3: Apply the concept of engineering scales, dimensioning and various geometric curves necessary to understand design of machine elements.

CO4: Analyze the concept of projection of line, surface and solids to create the knowledge baseof orthographic and isometric view of structures and machine parts.

CO5: Evaluate the design model to different sections of industries as well as for research &development.

CO-PO/PSO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2			2									2	2	2
CO2	2			2									2	2	2
CO3	3			2									2	2	2
CO4	3			3									3	3	2
CO5	3	2		3	2								3	3	2

Course Contents:

Basic Engineering Graphics: (3P)

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Module 1: Introduction to Engineering Drawing (6P)

Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module 2: Orthographic & Isometric Projections (6P)

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to

both planes; Projections of planes on inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Module 3: Sections and Sectional Views of Right Angular Solids (6P)

Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only).

Computer Graphics (3P) :

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

Module 4: Overview of Computer Graphics (3P)

Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

Module 5: CAD Drawing, Customization, Annotations, layering (6P)

Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerance; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, changing line lengths (extend/lengthen); Drawing sectional views of solids; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wireframe modeling, Part editing and printing documents.

Module 6: Demonstration of a simple team design project (3P)

Illustrating Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; Meshed topologies for engineering analysis and tool-path generation for component manufacture, use of solid-modeling software for creating associative models at the component and assembly levels.

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar PublishingHouse
2. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers

Reference Books:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, KhannaPublishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

2nd Year 3rd Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
A. THEORY					L	T	P	Total	
1	ENGG	Minor	DS 301	Digital Logic and Electronics	3	0	0	3	3
	ENGG	Major	DS302	Computer Organization and Architecture	3	0	0	3	3
2	ENGG	Major	DS 303	Data handling and visualization	3	0	0	3	3
4	ENGG	Minor	M(DS)301	Algebra and Differential Equations	3	1	0	4	4
		B. PRACTICAL							
1	ENGG	Minor	DS 391	Digital Logic and Electronics Lab	0	0	3	3	1.5
2	ENGG	Major	DS392	Computer Organization and Architecture Lab	0	0	3	3	1.5
3	ENGG	Major	DS 393	Data handling and visualization Lab	0	0	3	3	1.5
5	ENGG	Skill Enhancement Course	DS 394	Introduction to Python Programming Lab	0	0	3	3	1.5
		TOTAL CREDIT							19

Course Name: Digital Logic and Electronics
Course Code: DS301
Contact: 3:0:0
Credit: 3
Total Contact Hours: 36

Pre-requisite:
Basic concepts of Logic gates, Truth Tables, Concept of basic components of a digital computer.
Course Outcome(s):
CO1: To realize basic gate operations and laws Boolean algebra.
CO2: To understand basic mechanism of digital computers and digital logic behind different arithmetic and control unit operations.
CO3: To design combinational circuits and combinational functions for larger more complex circuits.
CO4: To perform different operations with sequential circuits.
CO5: To understand fundamental concepts and techniques used in Logic families and PLDs.

Course Content: –

Module – 1: [8L]
Binary Number System [1L]; BCD, ASCII, EBDIC, Gray codes and their conversions [1L], Introduction and laws of Boolean algebra [1L], Boolean functions, Minterm and maxterm, Prime implicants, Representation in SOP and POS forms[2L], Minimization of logic expressions by Karnaugh Map and algebraic method [3L]

Module – 2: [8L]
Combinational circuits:
Adder and Subtractor (half-full adder & subtractor) [2L], Serial & Parallel Adder, Carry look ahead adder and Parity Generator[2L], Encoder, Decoder, Multiplexer [2L], Demultiplexer, Comparator, Code Converters [2L]

Module – 3: [12L]
Sequential Circuits:
Flip-Flops, SR, JK, Master slave JK, D, T , characteristic Tables , Excitation tables [5L], Basic concept of Synchronous and Asynchronous counters, Up/Down Counters, Ring counter, Johnson counter, Design of Modulo-N Counter, Counter applications [5L], Registers (SISO, SIPO, PIPO, PISO) [2L]

Module – 4:[8L]
A/D and D/A conversion techniques – Basic concepts (D/A :R-2-R only [2L] , A/D: successive approximation [2L]), Logic families- TTL, ECL, MOS and CMOS - basic concepts [2L], Programmable logic Array, programmable Array logic, Sequential Programmable Devices [2L]

Text Book:
1. Salivahanan S, Digital Circuits and Design, Oxford
2. Morries Mano- Digital Logic Design- PHI

Reference Book:
1. R.P.Jain—Modern Digital Electronics, 2/e , Mc Graw Hill
2. Digital Fundamentals – A Systems Approach – Thomas L. Floyd, Pearson

CO-PO Mapping:

-

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	1	-	-	1	-
CO2	3	3	-	2	-	-	2	-	-	1	-	-
CO3	3	3	-	-	-	-	-	2	-	2	-	2
CO4	-	-	3	3	3	-	-	-	2	-	-	-
CO5	3	2	-	-	-	2	-	-	2		2	-

Course Name: Computer Organization and Architecture
Course Code:DS302
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisite: Digital Electronics

Course Outcomes (COs):

After attending the course students should be able to

CO1	Illustrate the basic concept of computer architecture and its performance measurement, parallel processing, Flynn's classification, and Amdahl's law and apply this knowledge in designing solutions for real life engineering problems.
CO2	Summarize the basic concept of pipeline, instruction pipeline, arithmetic pipeline hazards detection and prevention and use this knowledge for designing and implementing mathematical and engineering problems leading to lifelong learning.
CO3	Identify the concept of Instruction-Level Parallelism to solve engineering problems.
CO4	Illustrate and compare the concept of Multiprocessor architecture and parallel architecture and apply this knowledge for developing an approach by means of existing and new methods as a team work.
CO5	Understand the concept of message passing architecture and interconnection network and design an optimized model for building a new solution as a professional engineering practice as a team.

Course Contents:

Module 1[8L]:

Introduction to CPU and concepts of ALU[2L], Instruction format and Instruction Cycle[1L], Addressing Modes [1L] Fixed-point multiplication -Booth's algorithm. [2L], Fixed-point division - Restoring and non-restoring algorithms[1L], Floating-point number representation-IEEE754 format and Floating-point arithmetic operation[1L].

Module 2 [7L]:

Introduction to basic computer architecture [1L], Stored Program Concepts: Von Neumann & Harvard Architecture [1L], RISC VS CISC [1L], Amdahl's law [1L], Performance measurement parameters – MIPS, MFLOPS, SPEC ratings, CPI etc. [2L] Micro programmed and hardwired control unit [1L].

Module 3[8L]:

Pipelining: Basic concepts, instruction and arithmetic pipeline[2L], data hazards, control hazards and structural

hazards, techniques for handling hazards[2L], Pipeline vs. Parallelism, Levels of parallelism [1L], Instruction-Level Parallelism: Basic Concepts, Techniques for Increasing ILP, Superscalar, Super Pipelined and VLIW Processor Architectures [2L], Array and Vector Processors [1L]

Module 4[9L]:

Introduction to memory-RAM and ROM [1L], Register transfer, memory transfer, Tri-state bus buffer, Memory Hierarchy: Secondary memory [1L], Main Memory [1L], Cache Memory [1L], Mapping Technique in cache memory: Direct, Full Associative and Set Associative [2L], Performance Implementation in Cache Memory [1L], Virtual memory Concepts [1L], page replacement policies [1L].

Module 5[4L]:

Multiprocessor architecture: taxonomy of parallel architectures; Flynn‘s Classification [1L], Centralized and Shared- memory architecture: synchronization [1L], Interconnection Network (Omega, Baseline, Butterfly, Crossbar) [2L].

Text Books:

1. _Advanced Computer Architecture Parallelism Scalability Programmability‘, Tata McGraw-Hill Education

Private Limited ISBN-13: 978-0-07-053070-6 ISBN-10: 0-07-053070-X

2. Hwang & Briggs—Computer Architecture & Parallel Processing, TMH

Reference Books:

1. Patterson D.A. and Hennessy, J.L. ―Computer architecture a quantitative approach‖, 2nd

ed., Morgan Kaufman, 1996

2. Hayes J. P., ―Computer Architecture & Organisation‖, McGraw Hill

3. Siegel, H.J., ―Interconnection Network for Large Scale parallel Processing‖, 2nd Ed. McGraw Hill, 1990

4. Design and Analysis of Parallel Algorithm-Schim G. Akl

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	
CO1	3	3	3	2								
CO2	3	3	3	3								3
CO3	2	2	2	3								
CO4	3	3	3	3								
CO5	3	3	3	3								

CO-PSO Mapping

Cos	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Data Analysis and Visualization
Paper Code: DS302
Contact (L: T: P): 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

1. Basics knowledge of Mathematics.
2. Basic programming knowledge.

Course Objectives:

This course introduces students to data analysis and visualization in the field of exploratory data science using Python.

Course Outcomes (COs):

On successful completion of the course, the students will be able to:

CO1	Use data analysis tools in the pandas library.
CO2	Load, clean, transform, merge, and reshape data.
CO3	Create informative visualization and summarize data sets.
CO4	Analyse and manipulate time series data.
CO5	Solve real-world data analysis problems.

CO-PO/PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2									3	3	3
CO2	2	3	2	2									3	3	3
CO3	2	3	3	2									3	3	3
CO4	2	3	3	2									3	3	3
CO5	2	3	3	2									3	3	3

Course Content:

Module-1

Introduction: Introduction to Data Science, Exploratory Data Analysis, and Data Science Process. Motivation for using Python for Data Analysis, Introduction of Python shell iPython and Jupyter Notebook. Essential Python Libraries: NumPy, pandas, matplotlib, SciPy, scikit-learn, statsmodels

Module-2

Getting Started with Pandas: Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing, and Computing Descriptive Statistics. Data Loading, Storage, and File Formats. Reading and Writing Data in Text Format, Web Scraping, Binary Data Formats, interacting with Web APIs, Interacting with Databases Data Cleaning and Preparation. Handling Missing Data, Data Transformation, and String Manipulation.

Module-3

Data Wrangling: Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting.

Data Visualization matplotlib: Basics of matplotlib, plotting with pandas and seaborn, and other Python visualization tools

Module-4

Data Aggregation and Group operations: Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables, and cross tabulation.

Time Series Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency Conversion, and Moving Window Functions.

Module-5

Advanced Pandas: Categorical Data, Advanced GroupBy Use, Techniques for Method Chaining

Recommended Text Books

1. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. 2nd edition, McKinney, W. O'Reilly Media.
2. Doing Data Science: Straight Talk from the Frontline, O'Neil, C., & Schutt, R., O'Reilly Media.

Recommended Reference Books

1. R cookbook, Teetor, P., O'Reilly. ISBN 9780596809157.
2. R graphics cookbook. Chang, W., O'Reilly. ISBN 9781449316952.
3. Discovering Statistics Using R., Andy Field, Jeremy Miles and Zoe Field., SAGE Publications Ltd. ISBN-13: 978-1446200469.
4. An Introduction to Statistical Learning with Applications in R, Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, Springer.

Web Reference

1. https://www.openintro.org/stat/

Course Name: Algebra and Differential Equation
Paper Code: M(DS)301
Contact (L: T: P): 3: 1: 0
Total Contact Hours: 48
Credit: 4

Prerequisites:

The students to whom this course will be offered must have the concept of (10+2) standard matrix algebra, and calculus.

Course Objectives:

The objective of this course is to familiarize prospective engineers with techniques in linear algebra and differential equations. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well in tackling the more advanced level of mathematics and applications that they would find useful in data science.

Course Outcomes (COs):

On successful completion of the learning sessions of the course, the learner will be able to:

CO1: Recall the properties related to Linear algebra and Differential and Integral Calculus.

CO2: Determine the solutions to the problems related to Linear Algebra and Differential Equations.

CO3: Apply the appropriate mathematical tools of Linear Algebra and Differential Equations for the solutions of real-life problems.

CO4: Analyze different engineering problems with the help of Linear Algebra and Differential Equations.

CO-PO/PSO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	3	2	2	2	2	2	-	-	-	2	-	2
CO4	2	3	3	3	2	2	-	-	-	2	-	2
M(DS) 301	**2.75**	**2.25**	**2.5**	**2.5**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**1.75**

Weightage Values: Strongly mapped: ‘3’, Moderately mapped: ‘2’, Weakly mapped: ‘1’, Not mapped: ’-‘.

Course Content:

MODULE-1: System of Linear Equations [5L]
Gaussian elimination and Gauss Jordan methods, Elementary matrices, System of linear equations, LU factorizations.

MODULE-2: Vector Spaces [8L]
The Euclidean space and vector space, subspace, linear combination, span linearly dependent-independent, bases, dimensions, finite dimensional vector space, Replacement, Deletion and Extension of Bases.

MODULE-3: Linear Transformations and applications [12L]
Linear transformations, Basic properties, Row and column spaces, Rank and nullity, Bases for subspace, invertible linear transformation, matrices of linear transformations, vector space of linear transformations, change of bases, similarity.

MODULE-4: Inner Product Spaces [6L]
Dot products and inner products, the lengths and angles of vectors, matrix representations of inner products, Gram-Schmidt orthogonalization.

Module 5: First Order Ordinary Differential Equations (ODE) (9L)
Solution of first order and first-degree ODE: Exact ODE, Rules for finding Integrating factors, Linear ODE, Bernoulli's equation. Solution of first order and higher degree ODE: solvable for p, solvable for x, and solvable for y, and Clairaut's equation.

Module 6: Second Order Ordinary Differential Equations (ODE) (8L)
Solution of second order ODE with constant coefficients: C.F. & P.I., D- operator, Method of variation of parameters, Cauchy-Euler equations. Simultaneous Differential Equation

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Seymour Lipchutz, Marc Lipson, Schaum's Outline of Linear Algebra, 3rd Edition, 2017.

Reference Books:

1. Guruprasad, S. A text book of Engineering Mathematics-I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
6. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
7. Bronson, R., Schaum's Outline of Matrix Operations. 1988.

Course Name: Digital Logic and Electronics Lab
Course Code: DS391
Contact: 0:0:3
Credit: 1.5

Prerequisite:
Basic concepts of Logic gates, Truth Tables, function realization –minimization of Logic expressions by K-map, Concept of basic components of a digital computer, Binary Arithmetic

Course Outcomes (COs):
After attending the course students should be able to

CO1	Knowledge of Electronic components such as Resistors, Capacitors, Diodes, Transistors measuring equipment like DC power supply, Multimeter, CRO, Signal generator, DC power supply.
CO2	Analyze the characteristics of Junction Diode, Zener Diode, BJT & FET and different types of Rectifier Circuits.
CO3	Determination of input-offset voltage, input bias current and Slew rate, Common- mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
CO4	Able to know the application of Diode, BJT &OPAMP.
CO5	Familiarization and basic knowledge of Integrated Circuits

Course Content:

1. A) Realization of basic gates and universal gates.

B) Realization of basic gates using universal gates.

2. Design a Half adder and Full Adder circuit using basic gates and verify its output.

3. Design a Half subtractor and Full Subtractor circuit using basic gates and verify its output

4. Design an Adder/Subtractor composite unit.

5. Design of a Carry-Look-Ahead‘ Adder circuit.

6. Realization of a) Encoder, b) Decoder c) Multiplexer, d) Demux, e) Comparator and their Truth Table verification.

7. Realization of RS / JK / D flip flops using logic gates.

8. Design of Shift Register using J-K / D Flip Flop.

9. Realization of Synchronous Up/Down counters.

10. Design of MOD- N Counter

11. Study of DAC

12. Study of logic families and PLDs

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3							
CO2	3	3	3	3	3							
CO3	3	3	3	3	3							
CO4	3	3	3	3	3							
CO5	3	3	3	3	3							

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	2	2
CO3	2		2
CO4	2	2	2
CO5	2	2	2

Course Name: Computer Organization and Architecture Lab
Course Code: DS392
Contact: 0:0:3
Credits: 1.5

Prerequisites:
Knowledge of designing different circuits in Computer Organization Lab

Course Outcomes (COs):
After attending the course students should be able to

CO1	Illustrate and use proper syntax in appropriate platforms for developing programs to solve problems related to Mathematics and Engineering fields leading to lifelong learning.
CO2	Apply the knowledge of algorithms in the computational area to efficient programming codes to design the problem using modern tools for solving complex engineering problems.
CO3	Outline different types of digital electronic circuits such as adder, subtract or, encoder decoder, multiplexer, demultiplexer, flip-flops, register, counter using various mapping and modern tools to prepare the most simplified circuit and optimize using various mapping and mathematical methods for solving the problem as a professional engineering practice as a team.
CO4	Apply the knowledge of digital electronic circuits to design memory and ALU and analyze the same to solve engineering-related computational problems as a team.
CO5	Interpret the result of the experiments, prepare laboratory reports based on observed output and analyze it to validate professional ethics and responsibilities and norms of the engineering practice.

List of Experiment:
1. Implement different types of Basic gates and simulate for truth table verification.
2. Implement half adder circuit and simulate for truth table verification.
3. Implement full adder circuit and simulate for truth table verification.
4. Implement half subtractor circuit and simulate for truth table verification.
5. Implement a full subtractor circuit and simulate for truth table verification.
6. Implement Multiplexer, De Multiplexer circuit and simulate for truth table verification.
7. Implement Encoder, Decoder circuit and simulate for truth table verification.
8. Implement different types of flip flop and simulate for truth table verification.
9. Implement different types of parallel circuits (SISO, SIPO, PISO, PIPO) and simulate the result.
10. Implement ALU and simulate the result.
11. Implement a RAM chip and simulate the result.
12. Innovative Experiments.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3				3			
CO2	3	3	3	3	3				3			
CO3	3	3	3	3	3				3			
CO4	3	3	3	3	3				3			
CO5	3	3	3	3	3				3			

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Data Analysis and Visualization Lab
Paper Code: DS392
Contact (L: T: P): 0:0:3
Total Contact Hours: 36
Credit: 1.5

Prerequisites:

3. Basics knowledge of Mathematics.
4. Basic programming knowledge.

Course Objectives:

This course introduces students to data analysis and visualization in the field of exploratory data science using Python.

Course Outcomes (COs):

On successful completion of the course, the students will be able to:

CO1	Use data analysis tools in the pandas library.
CO2	Load, clean, transform, merge, and reshape data.
CO3	Create informative visualization and summarize data sets.
CO4	Analyse and manipulate time series data.
CO5	Solve real-world data analysis problems.

CO-PO/PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2									3	3	3
CO2	2	3	2	2									3	3	3
CO3	2	3	3	2									3	3	3
CO4	2	3	3	2									3	3	3
CO5	2	3	3	2									3	3	3

Course Content:

You can use the data set of your choice from Open Data Portal (https://data.gov.in/).

1. Practical based on numpy ndarray
2. Practical based on Pandas Data Structures
3. Practical based on Data Loading, Storage and File Formats
4. Practical based on Interacting with Web APIs
5. Practical based on Data Cleaning and Preparation
6. Practical based on Data Wrangling
7. Practical based on Data Visualization using matplotlib
8. Practical based on Data Aggregation
9. Practical based on Time Series Data Analysis

Recommended Text Books

3. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. 2nd edition, McKinney, W. O'Reilly Media.
4. Doing Data Science: Straight Talk from the Frontline, O'Neil, C., & Schutt, R., O'Reilly Media.

Recommended Reference Books

5. R cookbook, Teetor, P., O'Reilly. ISBN 9780596809157.
6. R graphics cookbook. Chang, W., O'Reilly. ISBN 9781449316952.
7. Discovering Statistics Using R., Andy Field, Jeremy Miles and Zoe Field., SAGE Publications Ltd. ISBN-13: 978-1446200469.
8. An Introduction to Statistical Learning with Applications in R, Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, Springer.

Web Reference

2. https://www.openintro.org/stat/

Course Name: Introduction to Python Programming Lab
Course Code: DS394
Contact (L: T: P): 0:0:3
Total Contact Hours: 36
Credit: 1.5

Prerequisites:
Knowledge of Mathematics and basic concepts of Programming

Course Outcome(s):
After completion of the course students will be able to
CO1: Understand basic of Python Programming Language
CO2: Understand the use of Conditional statement and Loops
CO3: Learn functions in python and represent collection type data using List and Dictionary
CO4: Read and write data from & to files in Python
CO5: Understand Numpy array and numerical operations on Numpy array.

Course Contents:

1. **Basics of Python:** Python Installation, python variables, data types and Operator.
2. **Loops:** While and For loops, Python Syntax, Colon & Indentation, ConditionalStatements: if, elif and else.
3. **Functions:** Defining Functions in python; passing arguments.
4. **String:** Python Programming to explore string functions
5. **Lists**: Python programs using Lists; understand the use of List methods, Slicing on List.
6. **Sets**: Working with Sets; Write programs to show different set operations.
7. **Dictionary**: Demonstrate the use of Dictionaries
8. **File handling:** Reading & Writing data from a file, Redirecting output streams to files.
9. **Numpy**: Numerical operations using Numpy array; slicing numpy array; stacking numpy arrays; Writeprograms to show different numerical operations on numpy array;.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	2	-	-	-	-	-	-	-	1
CO2	2	3	-	2	-	-	-	-	-	-	-	-
CO3	2	3	3	2	-	-	-	-	-	-	-	1
CO4	2	3	2	2	-	-	-	-	-	-	-	-
CO5	3	3	3	3	-	-	-	-	-	-	-	2

2nd Year 4th Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
A. THEORY					L	T	P	Total	
1	ENGG	Major	DS401	Operating Systems	3	0	0	3	3
2	ENGG	Major	DS402	Computer Networks	3	0	0	3	3
3	ENGG	Major	DS403	Formal Language and Automata Theory	3	0	0	3	3
4	HUM	Major	DS404	Design and Analysis of Algorithms	3	0	0	3	3
5	SCI	Minor	M(DS)401	Probability and Statistics	3	1	0	4	4
B. PRACTICAL									
1	ENGG	Major	DS491	Operating Systems Lab	0	0	3	3	1.5
2	SCI	Major	DS492	Computer Networks Lab	0	0	3	3	1.5
3	ENGG	Major	DS493	Programming for Data Science using R Lab	0	0	3	3	1.5
4	ENGG	Minor	M(DS)491	Numerical Methods Lab	0	0	3	3	1.5
		TOTAL CREDIT							22

Course Name: Operating System
Course Code: DS401
Contact (L: T: P): 0:0:3
Total Contact Hours: 36
Credit: 1.5
Prerequisites:
1. Computer organization
2. Computer Architecture
3. Data Structures
4. Algorithms & Programming Concept

Course Outcomes (COs):
After attending the course students should be able to

CO1	Understand the fundamental concepts of Operating System, Protection & Security and differentiate different types of Operating System.
CO2	Understand and implement process & thread; understand, apply, compare different process synchronization algorithm and inter process communication to solve engineering problems
CO3	Understand/explain/analyze different synchronization techniques, critical section problems and deadlock and apply them to solve engineering problems.
CO4	Understand/explain different memory management techniques including virtual memory management; also able to apply, compare, and implement different page replacement algorithms to solve engineering problems.
CO5	Understand/explain different I/O mechanisms, File structures and disk management techniques and solving engineering problems applying different disk scheduling algorithms.

Course Content:

Module – 1:[3L]
Functionalities of Operating System, Evolution of Operating System.
Types of Operating System: batch, multi-programmed, time-sharing, real-time, distributed, parallel, Structural overview, Protection & Security. [3L]

Module – 2:[11L]
Processes: Concept of processes, process states, PCB, process scheduling, co-operating processes, independent process, suspended process, Interaction between processes and OS, Inter-process communication: Message passing. [3L], Threads: overview, benefits of threads, user and kernel level threads, Thread models. [2L]
CPU scheduling: Scheduling criteria, preemptive & non-preemptive scheduling, scheduling algorithms (FCFS, SJF, SRTF, RR, priority, multilevel queue, multilevel feedback queue scheduling). [6L]

Module – 3:[11L]
Process Synchronization: background, critical section problem, synchronization hardware, classical problems of synchronization (producer-consumer, readers-writer, dining philosophers, etc), semaphores, monitors.[6L]
Deadlocks: deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock.[5L]

Module 4:[6L]
Background, logical vs. physical address space, swapping, contiguous memory allocation, paging, Segmentation, TLB. [3L], Virtual Memory: background, demand paging, page replacement algorithms (FCFS,

LRU, Optimal), thrashing, Working set model. [3L]

Module 5:[5L]
Disk structure, disk scheduling (FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK etc), disk reliability, disk formatting, boot block, bad blocks. [2L]
File: File concept, access methods, directory structure, file system structure, UNIX file structure, allocation methods (contiguous, linked, indexed), free-space management (bit vector). [2L]
I/O: I/O hardware, polling, interrupts, DMA, caching, buffering, blocking-non blocking I/O. [1L]

Text Book:
1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts.
2. Operating Systems & Systems Programming by P Balakrishna Prasad

Reference Book:
1. Dietel H. N., ―An Introduction to Operating Systems‖, Addison Wesley.
2. Andrew Tanenbaum, Modern Operating Systems, Prentice Hall.
3. William Stallings, Operating Systems, Prentice Hall.

CO-PO Mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Computer Networks
Course Code: DS402
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisite:
1. Familiarity and knowledge of Operating Systems and Computer Architecture.
2. Also require a little bit of programming languages concepts like C, Java**.**

Course Outcomes (COs):
After attending the course students should be able to

CO1	Understand basics of computer network and different architecture and topologies of computer network and analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
CO2	Understand/analyze different protocols of the data link layer and apply them to solve engineering problems.
CO3	Understand/analyze different protocols of Network and Transport Layer and apply them to solve engineering problems.
CO4	Understand/analyze different protocols of session and application layer and apply them to solve engineering problems.
CO5	Develop, Analyze, specify and design the topological and routing strategies using socket programming.

Course Contents:

Module 1: Introduction [6L]
Introduction (3L):
Introduction: Computer Network, data communication, topology, OSI & TCP/IP Reference Models, layers and characteristics, Wireless Network, comparison to wired and wireless network.
Physical Layer: [3L]
Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit switching: time division & space division switch, TDM bus; Telephone Network;

Module 2: Data Link Layer [10L]

Framing, Error Control, Error Detection and Correction, Flow Control, Data Link Protocols, Simple Stop-and-Wait Protocol, ARQ mechanism, Sliding Window Protocols, One-Bit Sliding Window Protocol, Go-Back-N and Selective Repeat, HDLC, PPP Medium Access Control Sub-layer, The Channel Allocation. [5L]
Multiple Access Protocols**:** ALOHA, Carrier Sense Multiple Access Protocols, IEEE 802.x Ethernet, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, 10 Gigabit Ethernet, Wireless LANs - IEEE 802.xx, Bluetooth, RFID,Bridges, Virtual LANs, Switching**.** [5L]

Module 3: Network Layer [10L]
IP Addressing, IPv4and IPv6. Difference IPv4and IPv6, Conversion ofIPv4and IPv6, Subnetting, Supernetting, Design Issues, Store-and-Forward Packet Switching, Virtual-Circuit and Datagram Networks, ARP, IP, ICMP, IPV6, BOOTP and DHCP–Delivery protocols Other Protocols such as mobile IP in wireless Network. [5L]

Routing: Shortest Path Algorithms, Flooding, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast Routing, Anycast Multicast Routing, BGP; Routing Routing: RIP, OSPF, for Mobile Hosts. [5L]

COs	PSO1	PSO2	PSO3

Module 4: Transport layer: [6L]
Process to Process delivery; UDP; TCP, SCTP, TCP RENO, TCP/IP in Wireless environment, Congestion control in TCP: Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm. [5L]
Advanced topic such as Remote Procedure Call, Delay Tolerant Networks. [1L]

Module 5: Application Layer [3L]

Introduction to DNS, SMTP, SNMP, FTP, HTTP & WWW: Cryptography (Public, Private Key based), DigitalSignature, Firewalls

Module 6: Socket Programming [1L]

Introduction to Socket Programming, UDP socket and TCP Socket

Text books:

1. B. A. Forouzan – ―Data Communications and Networking (3rd Ed.) ―– TMH
2. S. Tanenbaum – ―Computer Networks (4th Ed.)‖ – Pearson Education/PHI
3. W. Stallings – ―Data and Computer Communications (5th Ed.)‖ – PHI/ Pearson Education
4. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP

Reference books:

1. Kurose and Rose – ―Computer Networking -A top-down approach featuring the internet‖ – Pearson Education
2. Leon, Garica,Widjaja – ―Communication Networks‖ – TMH
3. Walrand – ―Communication Networks‖ – TMH.
4. Comer – ―Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.)‖ – Pearson Education/PHI

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2				2	2		3
CO2	3	3	3	3	3				2	2		3
CO3	3	3	3	3	3				2	2		3
CO4	3	3	3	3	3				2	2		3
CO5	2	3	3	3	3				2	2		3

CO-PSO Mapping

CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Formal Language and Automata Theory
Course Code: DS403
Contacts: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites:

1. Digital Logic
2. Computer organization
3. Computer Fundamentals

Course Outcomes (COs):

After attending the course students should be able to

CO1	Understand the fundamental concepts of Finite State Automata to Explain or Illustrate andIdentify problems where students can Apply the concept appropriately to Solve them.
CO2	Understand the fundamental concepts of Regular Expressions and its relation with DFA so thatthey can Develop regular expression for a specified language and Validate it.
CO3	Understand the fundamental concepts of Context Free Grammar so that they can Design grammafor a specified language and Validate it.
CO4	Explain or Illustrate the fundamental operating principles of Push Down Automata andUse it appropriately to Solve problems.
CO5	Understand the operating principles of Turing Machine and Design Turing Machines to Propose solutions to the related problems appropriately and validate the effectiveness as well as limitations of computations making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Contents:

Module-1:[9L]

Fundamentals: Basic definition of sequential circuit, block diagram, mathematical representation, concept of transition table and transition diagram,**[1L]**
Introduction to Finite State Model (FSM), Design of sequence detector, Finite State Machine, Finite Automata, Deterministic Finite Automation (DFA) and Non-deterministic Finite Automation (NFA), Transition diagrams, Transition tables and Language recognizers.**[3L]**
NFA with empty transitions, Equivalence between NFA with and without empty transitions. NFA to DFA conversion.**[2L],** Minimization of FSM: Minimization Algorithm for DFA, Introduction to Myhill-Nerode Theorem **[2L],** Limitations of FSM, Application of Finite Automata**[1L]**

Module-2:[7L]

Finite Automata with output − Moore & Mealy machine. Representation of Moore & Mealy Machine, Processing of the String through Moore & Mealy Machine, Equivalence of Moore & Mealy Machine – Inter- conversion.**[2L],** Equivalent states and Distinguishable States, Equivalence and k-equivalence, Minimization of, Mealy Machine**[1L]**, Minimization of incompletely specified machine−Merger Graph, Merger Table, Compatibility Graph [2L], Lossless and Lossy Machine – Testing Table, Testing Graph **[2L]**

Module-3:[5L]

Regular Languages, Regular Sets, Regular Expressions, Algebraic Rules for Regular Expressions, Arden'sTheorem statement and proof**[1L]**. Constructing Finite Automata (FA) for given regular expressions, Regular string accepted by FA**[2L]**, Constructing Regular Expression for

a given Finite Automata**[1L]**, Pumping Lemma of Regular Sets. Closure properties of regular sets**[1L]**

Module-4:[9L]

Grammar Formalism-Context Free Grammars, Derivation trees, sentential forms. Rightmost and leftmost derivation of strings, Parse Tree, Ambiguity in context free grammars.**[1L],** Minimization of Context Free Grammars. **[1L],**Removal of null and unit production**[1L]**Chomsky normal form and Greibach normal form.**[1L],** Pumping Lemma for Context Free Languages.**[1L],** Enumeration of properties of CFL, Closure property of CFL, Ogden's lemma & its applications **[1L],** Regular grammars−right linear and left linear grammars**[1L],** Pushdown Automata: Pushdown automata, definition. Introduction to DCFL, DPDA, NCFL, NPDA**[1L]** Acceptance of CFL, Acceptance by final state and acceptance by empty state and itsequivalence.**[1L]** Equivalence of CFL and PDA, inter-conversion.**1L]**

Module-5:[5L]

Turing Machine: Turing Machine, definition, model**[1L]**
Design of TM, Computable functions **[1L],** Church's hypothesis, counter machine **[1L]** Types ofTuring machines **[1L]**Universal Turing Machine, Halting problem**[1L]**

Textbook:

1. Introduction to Automata Theory Languages and Computation‖, Hopcroft.E. and Ullman J.D.,Pearson Education.

Reference Books:

1. Formal Languages and Automata Theory‖,C. K. Nagpal, Oxford
2. ‒Switching and Finite Automata Theory‖, Zvi Kohavi, 2nd Edition, Tata McGraw Hill

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								3
CO2	2	2	2	2								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3					2	2		3

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3

CO5	3	3	3

Course Name: Design & Analysis of Algorithm
Course Code:DS404
Contact: 3:1:0
Total Contact Hours: 36
Credits: 3

Prerequisites: To know data-structure and basic programming ability
Course Outcomes (COs):
After attending the course students should be able to

CO1	To understand and illustrate the concepts of time and space complexity, worst case, average case and best-case complexities and the asymptotic notation.
CO2	To analyze and apply the design principles and concepts to various basic algorithm design viz. dynamic programming, greedy methods etc.
CO3	To understand and analyze various string matching and graph algorithms.
CO4	To understand, illustrate and analyze the different complexity classes
CO5	To discuss, implement and analyze, verify the efficiency of the randomized and approximation algorithms.

Course Content:
Module-1 [4L]

Algorithm Development & Complexity Analysis: [4L] Stages of algorithm development for solving a problem: Describing the problem, identifying a suitable technique, Design of an algorithm, Proof of Correctness of the algorithm. Time and Space Complexity, Different Asymptotic notations – their mathematical significance. Solving Recurrences: Substitution Method, Recurrence Tree Method, Master Theorem (Statement Only).

Module-2 [14L]

Algorithm Design Techniques: Brute force techniques – Traveling Salesman Problem, Divide and Conquer - Matrix multiplication: Strassen‘s algorithm, Greedy techniques - Fractional Knapsack problem, Job Sequencing with Deadline, Graph Coloring, Finding Minimum Cost Spanning Tree, Dynamic programming - O/1 Knapsack problem, Matrix chain multiplication, Travelling Salesman Problem, Backtracking-N-Queens Problem, Knights Tour on Chess Board.

Module-3 [3L]

String matching problem: Different techniques – Naive algorithm, string matching using finite automata, and Knuth, Morris, Pratt (KMP) algorithm with their complexities.

Module-4 [5L]

Graph Algorithms Single Source Shortest Path – Dijkstra‘s Algorithm, All pair shortest path – Floyd-Warshall Algorithm. Network Flows, Maximum Flows – Ford-Fulkerson Algorithm, Push Re-label Algorithm, Minimum Cost Flows – Cycle Cancelling Algorithm.

Module-5 [5L]

Complexity Classes:The Class P, The Class NP, Reducibility and NP-completeness – SAT (without proof), 3-SAT, Vertex Cover, Independent Set, Maximum Clique.

Module-6 [5L]

Approximation and Randomized Algorithms [3L], Approximation Algorithms - The set-covering problem – Vertex cover, K-center clustering. Randomized Algorithms - The hiring problem, Finding the global Minimum. Recent Trends [2L]

Text book:

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.

2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman. 3. "Algorithm Design" by Kleinberg and Tardos**.**
3. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House, New Delhi Reference Books:
4. ―Design Analysis and Algorithms‖ by Hari Mohan Pandey.

CO-PO Mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2								2
CO2	3	3	3	3								2
CO3	3	3	3	3								2
CO4	3	3	3	3								2
CO5	3	3	3	3								2

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Probability and Statistics
Course Code: M(DS)401
Contacts: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisite:

The students to whom this course will be offered must have the concept of (10+2) standard algebra andcalculus.

Course Outcome(s):

After completion of the course students will be able to

CO1: Recall the distinctive principles of probability and statistics.
CO2: Understand the theoretical workings of theory of probability and tests of hypotheses.
CO3: Apply statistical methods to compute and explain point estimators and interval estimators for mean, variance and proportion.
CO4: Analyze statistical data from engineering experiments.

Course Content

Module 1: (Probability and Random Variables) (15 Hours)

The axioms of probability, Conditional probability, Baye_s theorem, Discrete and continuous random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, Moments, Moment generating functions, Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

Module 2 (Two dimensional random variables) (5 Hours)

Joint distributions, Marginal and conditional distributions, Covariance, Correlation and linear regression, Transformation of random variables, Central limit theorem (for independent and identically distributed randomvariables).

Module 3 (Sampling Distribution) (3 Hours)

Distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems

Module 4 (Estimation) (4 Hours)

Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.

Module 5 (Testing of Hypotheses) (9 Hours)

Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chi square goodness of fit test and its applications, problems.

Project Domains:

1. Construction of Univariate and Bivariate frequency tables
2. Diagrammatic and Graphical representation of data.
3. Fitting of discrete and Continuous distributions

4. Regression Analysis
5. Curve Fitting
6. Tests of significance with regard to Single Mean, Two Means
7. Construction of Confidence intervals for Mean, Variance and Proportion

Text and Reference Books:

1. Sheldon M. Ross, ‐Introduction to Probability and Statistics for Engineers and Scientists‖, Academic Press, (2009).
2. D. C. Montgomery and G.C. Runger, ‐Applied Statistics and Probability for Engineers‖, 5th edition, John Wiley & Sons, (2009)..
3. Robert H. Shumway and David S. Stoffer, ‐Time Series Analysis and Its Applications with R Examples‖, Third edition, Springer Texts in Statistics, (2006).
4. N. G. Das: Statistical Methods, TMH.
5. Sancheti *, D. S. &*Kapoor *,V.K. : Statistics Theory , Method & Application,* Sultan chand & sons , NewDelhi
6. N.K.Dutta (2004). Fundamentals of Biostatistics, Kanishka Publishers.

CO-PO Mapping:

PO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1	3	1	1	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	3	-	-	-	-	-	-	-	2

Course Name: Operating Systems Lab
Course Code: DS491
Allotted Hours: 36L

Prerequisites:

1. Computer organization
2. Computer Architecture
3. Data Structures
4. Algorithms & Programming Concept

Course Outcomes (COs):

After attending the course students should be able to

CO1	Analyze and simulate CPU Scheduling Algorithms like FCFS, Round Robin, SJF,and Priority.
CO2	Understand the concepts of deadlock in operating systems.
CO3	Implement them in Multiprogramming system.
CO4	Create process creation and implement inter process communication
CO5	Analyze the performance of the various page replacement schemes

Course Contents:

1. **Essential Linux Commands[9P]:** Commands for files and directories cd, cp, mv, rm, mkdir, more, less, creating and viewing files, using cat, file comparisons, View files, kill, ps, who, sleep, grep, fgrep, find,sort, cal, banner, touch, file related commands – ws, sat, cut, grep etc. Mathematical commands –expr,factor, units, Pipes(use functions pipe, popen, pclose), named Pipes (FIFOs, accessing FIFO)

2. **Shell Programming [6P]:** Creating a script, making a script executable, shell syntax (variables, conditions,control structures, functions, and commands).
3. **Process [3P]**: Starting new process, replacing a process image, duplicating a process image.

4. **Semaphore [3P]:** Programming with semaphores (use functions semget, semop, semaphore_p
5. **POSIX Threads[6P]:** Programming with pthread functions(viz. pthread_create, pthread_join, pthread_exit,pthread_attr_init, pthread_cancel) .
6. **Shared Memory [9P]:**Create the shared memory , Attach the shared memory segment to the address space of the calling process , Read information from the standard input and write to the shared memory,
   Read the content of the shared memory and write on to the standard output , Delete the shared memory

Books:

1. Yashavant P. Kanetkar, UNIX Shell Programming, 1st edition, BPB Publications
2. Beej's Guide to Unix IPC
3. W. Richard Stevens, UNIX Network Programming, 2nd edition, Prentice Hall

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3				3			
CO2	3	3	3	3	3				3			
CO3	3	3	3	3	3				3			
CO4	3	3	3	3	3				3			
CO5	3	3	3	3	3				3			

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Computer Networks Lab
Course Code: DS492
Allotted Hours: 36L

Prerequisites:
Familiarity and knowledge of Computer Network and Computer Architecture
Also require strong knowledge of programming languages like C, Java and UNIX or Linux environment.

Course Outcomes (COs):
After attending the course students should be able to

CO1	To design and implement small size network and to understand various networking commands.
CO2	To provide the knowledge of various networking tools and their related concepts.
CO3	To understand various application layer protocols for its implementation in client/server environment
CO4	Understand the TCP/IP configuration for Windows and Linux
CO5	Learn the major software and hardware technologies used on computer networks

Course Contents:
Familiarization of UNIX or Linux environment, UNIX or Linux general Commands specially Network Commands. Familiarization of Internetworking - Network Cables - Color coding - Crimping. Internetworking Operating Systems - Configurations. [6L]
Socket Programming using TCP and UDP [18L]
Implementing routing protocols such as RIP, OSPF. [2L]
Familiarization of advanced simulators like Packet Tracer, NS2/NS3, OMNET++, TinyOS[4L]
Server Configuration: only web server (If time permit, Instructor can do more than that) [6L]

Textbooks:
TCP sockets in C Programs-Practical guide for Programmers ByMicheal, J Donahoo and Kenneth L calvert.
Socket Programming by Raj Kumar Buyaa.

CO-PO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	3							2
CO2	3	3	3	3	3							2
CO3	3	3	3	3	3							2
CO4	3	3	3	3	3							2
CO5	2	3	2	2	3							2

CO-PSO Mapping

COs	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

Course Name: Programing for Data Science Using R Lab
Course Code: DS493
Contact Hours (per week): 3
Credit: 1.5
Allotted Hours: 36L

Pre-requisites:
Data Structure, Design and Analysis of Algorithms, Statistics, Artificial Intelligence, Concept of any Programming Language.

Course Objectives:
1. Identify the appropriate patterns in the data.
2. Obtain, clean/process, and transform data.
3. Analyze the data using several statistical techniques.
4. Construction of data-driven decision models.
5. Use business data to evaluate various marketing strategies.
6. Data analytics to make predictions based on available data.

Course Outcomes:
After completion of the course students will be able to
CO1: Identify the appropriate patterns in the data.
CO2: Summarize the information content in a large data set.
CO3: Extract knowledge from the data sets.
CO4: Construct data-driven decision models.
CO5: Use historical data to predict future outcomes.

COURSE CONTENT
WEEK-1: Write an R program to find Principal Components using KL-Transform of a given data set.

WEEK-2: Write an R program to find discriminatory components using Multiple Discriminant Analysis for a given data set.

WEEK -3: Regression
Implementation and Analysis of Linear and Nonlinear Regression using R programming.

WEEK -4: Classification 1
Implementation and Analysis of k-Nearest-Neighbor Classifier

WEEK -5: Classification 2
Implementation and analysis of Decision Tree Classifier, Naïve Bayes Classifier using R programming.

WEEK -6: Classification 3
Implementation and analysis of ANN-Backpropagation using R programming.

WEEK -7: Classification 4
Implementation and analysis of Linear SVM Based Classifier using R programming.

WEEK-8: Classification
Implementation and analysis of Linear SVM Based Classifier using R programming.
WEEK -9:
Write an R program to find solution of an over determined system of equations using Least Square Method.

WEEK -10:
Write an R program to construct a ensembled decision tree or Random Forest.

WEEK -11: Clustering
Implementation and Analysis of k-Means and k-Medoids using R programs.

WEEK -12:
Write an R program for time series forecasting using ARIMA method.

Textbook:
1. 'R for Data Science', Hadley Wickham, 1st edition, O′Reilly
2. 'The Book of R', Tilman M. Davies, 1st edition, No Strach Press

Reference Books:
1. Discovering Statistics Using R, Andy Field, 1st edition, SAGE Publications Ltd.
2. The Art of R Programming, Norman Matloff, 1st edition, No Starch Press.

Course Name: Numerical Methods Lab
Course Code: M(CS)491
Allotted Hours: 30L

Prerequisite: Any introductory course on programming language (example. C/ Matlab).

Course Outcomes (COs):

After attending the course students should be able to

CO1	Describe and explain the theoretical workings of numerical techniques with the help of C
CO2	Compute basic command and scripts in a mathematical programming language
CO3	Apply the programming skills to solve the problems using multiple numerical approaches.
CO4	Analyze if the results are reasonable, and then interpret and clearly communicate the
CO5	Apply the distinctive principles of numerical analysis and the associated error measures.

Course Content:

1. Assignments on Newton forward /backward, Lagrange‘s interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson‘s 1/3 rule, Weddle‘s rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination, Tridiagonalmatrix algorithm, Gauss-Seidel iterations. LU Factorization method.
4. Assignments on numerical solution of Algebraic Equation by Bisection method, Regula-Falsi method,Secant Method, Newton-Raphson method
5. Assignments on ordinary differential equation: Euler‘s method, Euler‘s modified method, Runge-Kuttamethods, Taylor series method and Predictor-Corrector method.
6. Implementation of numerical methods on computer through C/C++ and commercial Software Packages:Matlab / Scilab / Labview /Mathematica/NAG (Numerical Algorithms Group)/Python.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2			3			
CO2	3	3	2	2	3	2			3			
CO3	3	3	2	2	3	2			3			
CO4	3	3	2	2	3	2			3			
CO5	3	3	2	2	3	2			3			

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	2	2
CO3	2	2	2
CO4	2	2	2
CO5	2	2	2

3rd Year 5th Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
A. THEORY					L	T	P	Total	
1	ENGG	Major	DS501	Artificial Intelligence	3	0	0	3	3
2	ENGG	Major	DS502	Database Management Systems	3	0	0	3	3
3	ENGG	Minor	IT(DS)501	Object Oriented Programming using Java	3	0	0	3	3
4	ENGG	Major	DS504A	Compiler Design	3	0	0	3	3
			DS504B	Cryptography and Network Security					
			DS504C	Big Data Analytics					
5	HUM	Ability Enhancement Course	HU(DS)501	Business Communication and Value Science	2	0	0	2	2
B. PRACTICAL									
1	ENGG	Major	DS591	Artificial Intelligence Lab	0	0	3	3	1.5
2	ENGG	Major	DS592	Database Management Systems Lab	0	0	3	3	1.5
3	ENGG	Minor	IT(DS)591	Object Oriented Programming using Java Lab	0	0	3	3	1.5
4	Skill Enhancement Course	Internship	DS581	Internship/Industrial Training	0	0	2	2	2
		TOTAL CREDIT							20.5

Course Name: ARTIFICIAL INTELLIGENCE
Course Code: DS501
Contact (Periods/Week): = 3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite: Data Structure, Design and Analysis of Algorithms, Statistics

Course Objectives: The objective of the course is to enable students to

4. Comprehend the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context
5. Formulate a problem as State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.
6. Use the strategies of AI-Heuristics to find acceptable solutions avoiding brute-force techniques.
7. Design AI-Frameworks for Inferencing based on knowledge base.
8. Analyze the effectiveness of an AI-Inferencing Modeling offering solutions to the respective problem.

Course Outcomes	Name of Course Outcomes
CO1	To Understand and explain the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	To Identify and formulate an engineering problem primarily to fit a State-Space Exploration Framework or an Inferencing Agent Design Framework within the scope of Artificial Intelligence paradigm.
CO3	To Explore relevant literature and apply the concept of Heuristic Techniques or Inferencing Models of Artificial Intelligence to solve problems.
CO4	To Develop Inferencing Models for proposing solutions to the problems of Artificial Intelligence.
CO5	To Implement Inferencing Models of Artificial Intelligence through developing feasible algorithms and investigate their effectiveness by analyzing their performances in solving the relevant problems.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	3	3	-	-	-	-	-	-	-	-	-	-	-
	2.20	**2.20**	**1.60**	**1.60**	**-**	-	-	-	-	-	-	**0.60**	**-**	**-**	**-**

Course Content:

Module-1: Introduction to Artificial Intelligence [2L]
Basic Concepts, History of Artificial Intelligence, Architecture of an Artificial Intelligent Agent, Applications of Artificial Intelligence.

Module-2: Artificial Intelligence Problem Formulation as State-Space Exploration Problem for Goal Searching [8L]
Basic Concepts, State-Space Exploration Formulation for Water Jug Problem, Missionaries and Cannibals Problems, Farmer-Wolf-Goat-Cabbage Problem, 8-Puzzle Problem, Constraint Satisfaction Problem and Production System for Goal Searching. Blind Search Techniques for Goal Searching: Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bi-directional Search.

Module-3: Heuristic Techniques for Goal Searching [8L]
Basic Concepts of Heuristic Techniques and Properties of Heuristic Functions, Hill Climbing Search.Best First Search, A* Search, AO* Search Genetic Algorithm Based Evolutionary Search, Ant Colony Optimization, Particle Swarm Optimization.

Module-4: Adversarial Search for Game Playing [3L]
Basic Concepts, Minimax Search, Alpha-Beta Pruning.

Module-5: Knowledge Representation and Inference using Propositional Logic and Predicate Logic [5L] Propositional Logic: Knowledge Representation and Inference using Propositional Logic Predicate Logic: Knowledge Representation, Inference and Answer Extraction using First Order Predicate Logic.

Module-6: Reasoning under Uncertainty [5L]
Bayesian Inferencing and Bayesian Belief Network, Dempster-Shafer Theory, Overview of Fuzzy Logic and Inferencing.

Module–7: Introduction to Natural Language Processing [2L]
Basic Concepts, Steps of Natural Language Processing, Morphological, Syntactic and Semantic Analysis, Discourse Integration and Pragmatic Analysis, Applications of Natural Language Processing.

Module-8: Introduction to Machine Learning [3L]
Basic concepts of Machine Learning Model, Supervised Learning, Unsupervised Learning, and Reinforced Learning, Overview of Artificial Neural Network.

Text book:

1. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.
2. Rich, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGrawHill.

Reference Books:

1.Padhy, N.P. 2009. Artificial Intelligence and Intelligent Systems, Oxford University Press.
2.Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill.

Course Name: DATABASE MANAGEMENT SYSTEMS
Course Code: DS502
Contact (Periods/Week): = 3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:
1. Logic of programming language
2. Basic concepts of data structure and algorithms

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
CO1	To Understand and Describe the basic concepts and utility of Database management system, different data models of Database management system.
CO2	To Design an Entity Relationship (E-R) Diagram and relational model for any kind of real-life application and able to Apply relational algebra operations, SQL, Neo4j for solving
CO3	To Analyze and Create the relational database for any real-life applications based on normalization.
CO4	To Apply the query optimization techniques, different file organization techniques and Determine whether the transaction satisfies the ACID properties.
CO5	To Implement and organize the database of an organization as a team.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	-	-	-	-	3	3	3	3
CO2	3	3	2	2	-	-	-	-	-	-	-	3	3	3	3
CO3	3	3	2	2	-	-	-	-	-	-	-	3	3	3	3
CO4	3	3	2	2	-	-	-	-	-	-	-	3	3	3	3
CO5	3	3	2	2	-	-	-	-	-	-	-	3	3	3	3
	3.0	3.0	2.0	2.0	-	-	-	-	-	-	-	3.0	3.0	3.0	3.0

Course Content:

Module-1: Introduction [3L]
Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Module-2: Entity-Relationship and Relational Database Model [11L]
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features, case study on E-R Model. Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

Module-3: SQL and Integrity Constraints [6L]

Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

Module-4: Relational Database Design [8L]

Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF, Case Study

Module-5: Internals of RDBMS [9L]

Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols; two phase locking, Dead Lock handling.

Module-6 File Organization & Index Structures [6L]

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single Level Index (primary, secondary, clustering), Multilevel Indexes

Text book:

1. Henry F. Korth and Silberschatz Abraham, ―Database System Concepts‖, Mc.Graw Hill.

2. Elmasri Ramez and Novathe Shamkant, ―Fundamentals of Database Systems‖, Benjamin Cummings Publishing.Company.

Reference Books:

1. Fundamentals of Database Systems‖, Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing
2. Ramakrishnan: Database Management System, Mc Graw Hill

Course Name: OBJECT ORIENTED PROGRAMMING USING JAVA
Course Code: IT(DS)501
Contact (Periods/Week): = 3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:

1. Partial Object Oriented Programming using C++

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
IT(DS)501.1	**Design the process of interaction between Objects, classes & methods w.r.t. Object Oriented Programming.**
IT(DS)501.2	**Acquire a basic knowledge of Object Orientation with different properties as well as different features of Java.**
IT(DS)501.3	**Analyze various activities of different string handling functions with various I/O**
IT(DS)501.4	**Discuss basic code reusability feature w.r.t. Inheritance, Package and Interface.**
IT(DS)501.5	**Implement Exception handling, Multithreading and Applet (Web program in java)**

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
IT(DS)501.1	3	3	2	3	2	-	-	-	-	-	-	3	3	3	3
IT(DS)501.2	3	3	2	3	2	-	-	-	-	-	-	3	3	3	3
IT(DS)501.3	3	3	2	3	2	-	-	-	-	-	-	3	3	3	3
IT(DS)501.4	3	3	2	3	2	-	-	-	-	-	-	3	3	3	3
IT(DS)501.5	3	3	2	3	2	-	-	-	-	-	-	3	3	3	3
	3.0	3.0	2.0	3.0	2.0	-	-	-	-	-	-	3.0	3.0	3.0	3.0

Course Content:

Module 1 [2L]
Introduction: Object Oriented Analysis (OOA) & Object Oriented Design (OOD) - Concepts of object oriented programming language, Relationships among objects and classes-Generalization, Specialization, Aggregation, Association, Composition, links, Meta-class. [1L]; Object Oriented Programming concepts - Difference between Java and C++; Different features of Java [1L];

Module 2 [10L]
Java Basics: Basic concepts of java programming - Advantages of java, Byte-code & JVM, Data types, Different types of Variables.[1L] ;Java Operators & Control statements [1L]; Java loops. [1L]; Array [1L]; Creation of class, object, method. [1L]; Constructor- Definition, Usage of Constructor, Different types of Constructor [1L]; finalize method and garbage collection, Method & Constructor overloading. [1L]; this keyword, use of objects as parameter & methods returning objects [1L]; Call by value & call

by reference. [1L]; Static variables & methods, Nested & inner classes [1L].

Module 3 [5L]

Basic String handling & I/O: Basic string handling concepts- Concept of mutable and immutable string, Methods of String class- charAt(), compareTo(), equals(), equalsIgnoreCase(), indexOf(), length() , substring(). [1L]; toCharArray(), toLowerCase(), toString(), toUpperCase() , trim() , valueOf() methods, Methods of String buffer class- append(), capacity(), charAt(), delete(), deleteCharAt(). [1L];ensureCapacity(), getChars(), indexOf(), insert(), length(), setCharAt(), setLength(), substring(), toString(). [1L]; Command line arguments, basics of I/O operations – keyboard input using BufferedReader [1L] ; Scanner class in Java I/O operation [1L];

Module 4: [8L]

Inheritance and Java Packages: Inheritance - Definition, Advantages, Different types of inheritance and their implementation. [1L] ;Super and final keywords, super() method. [1L]; Method overriding, Dynamic method dispatch.[1L]; Abstract classes & methods.[1L]; Interface - Definition, Use of Interface.[1L]; Multiple inheritance by using Interface.[1L] ;Java Packages -Definition, Creation of packages. [1L]; Java Access Modifiers - public, private, default and protected, Importing packages, member access for packages. [1L]

Module 5: [11L] Exception handling, Multithreading and Applet Programming:

Exception handling - Basics, different types of exception classes.Difference between Checked & Unchecked Exception.[1L]; Try & catch related case studies.[1L]; Throw, throws & finally. [1L]; Creation of user defined exception. [1L]; Multithreading - Basics, main thread [1L]; Thread life cycle.[1L]; Creation of multiple threads-yield(), suspend(), sleep(n), resume(), wait(), notify(), join(), isAlive().[1L] ;Thread priorities, thread synchronization.[1L];Interthread communication, deadlocks for threads[1L]; Applet Programming - Basics, applet life cycle, difference between application & applet programming[1L]; Parameter passing in applets. [1L]

Text book:

1. Herbert Schildt – "Java: The Complete Reference " – 9th Ed. – TMH.

2. E. Balagurusamy – " Programming With Java: A Primer " – 3rd Ed. – TMH.

Reference Books:

1. R.K Das – " Core Java for Beginners " – VIKAS PUBLISHING.
2. Rambaugh, James Michael, Blaha – " Object Oriented Modelling and Design " – Prentice Hall, India.

Course Name: COMPILER DESIGN
Course Code: DS504A
Contact (Periods/Week): = 3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:

1. Mathematics
2. Concept of programming languages
3. Data structures
4. Computer architecture
5. Formal languages and automata theory
6. Some advanced math might be required if you Adventure in code optimization

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
DS504A.1	Illustrate the basic concept of compilers and discuss on the components as well as the strengths and weaknesses of various phases of designing a compiler.
DS504A.2	Design and analyze algorithms for syntactic or parsing techniques and semantic analysis of the process of designing compilers.
DS504A.3	Develop the parsers and experiment the knowledge of activation tree, activation record and dynamic storage allocation techniques
DS504A.4	Construct the intermediate code representations and generation
DS504A.5	Apply for various optimization techniques for dataflow analysis.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS504A.1	3	3	2	3	-	-	-	-	-	-	-	3	3	3	3
DS504A.2	3	3	2	3	-	-	-	-	-	-	-	3	3	3	3
DS504A.3	3	3	2	3	-	-	-	-	-	-	-	3	3	3	3
DS504A.4	3	3	2	3	-	-	-	-	-	-	-	3	3	3	3
DS504A.5	3	3	2	3	-	-	-	-	-	-	-	3	3	3	3
	3.0	3.0	2.0	3.0	-	-	-	-	-	-	-	3.0	3.0	3.0	3.0

Course Content:

Module-1[7L]
Compilers, Cousins of the Compiler, Analysis-synthesis model, Phases of the compiler, Role of the lexical analyser, Tokens, Patterns, Lexemes, Input buffering, Specifications of a token, Recognition of tokens, Finite automata, From a regular expression to an NFA, From regular expression to DFA, Design of a lexical analyser generator(Lex).

Module-2[10L]

The role of a parser, Context free grammars, Writing a grammar, Top down Parsing, Non-recursive Predictive parsing (LL),Bottom up parsing, Handles, Viable prefixes, Operator precedence parsing, LR parsers (SLR, LALR, Canonical LR), Parser generators (YACC), Error Recovery strategies for different parsing techniques, Syntax directed translation: Syntax directed definitions, Construction of syntax trees, Bottom-up evaluation of S- attributed definitions, L-attributed definitions, Bottom-up evaluation of inherited attributes.

Module-3[7L]
Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions, Source language issues (Activation trees, Control stack, scope of declaration, Binding of names), Symbol tables, dynamic storage allocation techniques.

Module-4[4L]
Intermediate languages, Graphical representation, Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).

Module-5 [8L]

Consideration for Optimization, scope of optimization, local optimization, loop optimization, folding, DAG representation, Flow Graph, Dataflow equation, global optimization, redundant sub expression elimination, induction variable elimination, copy propagation, basic blocks & flow graphs ,transformation of basic blocks, DAG representation of basic blocks, peephole optimization, Object code forms, machine dependent code optimization, register allocation and assignment, generic code generation algorithms, DAG for register allocation.

Text book:

1. Aho, A.V.,Sethi,R.,&Ullman,J.D.Addison-Wesley,2007.Compilers-Principles,Techniques,andTools.
2. Holub, A. I.(1990).CompilerdesigninC(Vol.5).EnglewoodCliffs,NJ:PrenticeHall.

Reference Books:

1. Chattopadhyay, S.(2005). Compiler Design. PHI Learning Pvt. Ltd.
2. Tremblay, J.P., &Sorenson, P.G.(1985).Theory and Practice of Compiler Writing. McGraw-Hill, Inc.
3. Appel, A.W.(2004). Modern compiler implementation in C. Cambridge university press.
4. Barrett, W.A.,Bates, R.M.,Gustafson, D.A.,& Couch,J.D.(1986). Compiler construction: theory and practice. SRA School Group. CO

Course Name: CRYPTOGRAPHY AND NETWORK SECURITY
Course Code: DS504B
Contact (Periods/Week): = 3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:
1. Knowledge of Computer Networks and Operating Systems fundamentals
2. Understanding of Discreet Mathematics concepts

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
DS504B.1	Understand cryptography and network security concepts and application.
DS504B.2	Apply security principles to system design.
DS504B.3	Identify and investigate network security threat
DS504B.4	Analyze and design network security protocols.
DS504B.5	Conduct research in network security.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS504B.1	3	3	2	2	2	-	-	-	-	-	-	-	3	3	3
DS504B.2	3	2	2	2	2	-	-	-	-	-	-	-	3	2	2
DS504B.3	2	3	2	2	3	-	-	-	-	-	-	-	2	2	2
DS504B.4	2	2	3	2	3	-	-	-	-	-	-	-	3	3	3
DS504B.5	3	2	2	2	2	-	-	-	-	-	-	-	3	3	3
	2.6	2.4	2.2	2.0	2.4	-	-	-	-	-	-	-	2.8	2.6	2.6

Course Content:

Module-1 [7L]
Introduction - Services, Mechanisms, and Attacks, OSI security architecture, Network security model[1L] Classical Encryption techniques (Symmetric cipher model, substitution techniques, transposition techniques, steganography) [3L] Finite Fields and Number Theory: Groups, Rings, Fields, Modular arithmetic, Euclid‘s algorithm[1L] Polynomial Arithmetic, Prime numbers, Fermat‘s and Euler‘s theorem[1L] Testing for primality -The Chinese remainder theorem - Discrete logarithms [1L]

Module-2 [9L]
Data Encryption Standard- Block cipher principles, block cipher modes of operation[2L] Advanced Encryption Standard (AES), Triple DES, Blowfish, RC5 algorithm[3L] Public key cryptography: Principles of public key cryptosystems, The RSA algorithm[2L] Key management - Diffie Hellman Key

exchange, Elliptic curve arithmetic, Elliptic curve cryptography [2L]

Module-3 [6L]
Authentication requirement, Authentication function, MAC, Hash function [2L] Security of hash function and MAC, MD5, SHA, HMAC, CMAC [2L] Digital signature and authentication protocols, DSS, ElGamal, Schnorr [2L]

Module-4 [7L]
Authentication applications, Kerberos, X.509 [1L] Internet Firewalls for Trusted System: Roles of Firewalls, Firewall related terminology- Types of Firewalls, Firewall designs principles [1L] SET for E-Commerce Transactions [1L] Intruder, Intrusion detection system [1L] Virus and related threats, Countermeasures [1L] Trusted systems, Practical implementation of cryptography and security [2L]

Module-5 [7L]

E-mail Security: Security Services for E-mail-attacks possible through E-mail, Establishing keys privacy, authentication of the source [1L] Message Integrity, Non-repudiation, Pretty Good Privacy, S/MIME [2L] IP Security: Overview of IPSec, IPv4 and IPv6-Authentication Header, Encapsulation Security Payload (ESP) [1L], Internet Key Exchange (Phases of IKE, ISAKMP/IKE Encoding) [1L] Web Security: SSL/TLS Basic Protocol, computing the keys, client authentication [1L] PKI as deployed by SSL Attacks fixed in v3, Exportability, Encoding, Secure Electronic Transaction [1L]

Text book:

1. Kahate, A. (2013). Cryptography and network security.Tata McGraw-Hill Education.
2. Forouzan, B. A., & Mukhopadhyay, D. (2015). Cryptography and network security. New York, NY: Mc Graw Hill Education (India) Private Limited.

Reference Books:

1. Stallings, W. (2006). Cryptography and network security, 4/E. Pearson Education India.
2. Daras, N. J., & Rassias, M. T. (Eds.). (2015). Computation, cryptography, and network security (pp. 253- 287).Springer.
3. Kumar, A., & Bose, S. (2017). Cryptography and network security.Pearson Education India.

Course Name: BIG DATA ANALYSIS
Course Code: DS504C
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:

1. Data Structure, Design and Analysis of Algorithms, Database Management Systems, Statistics, Artificial Intelligence, Programming skills of Python.

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
DS504C.1	Understand and explain the fundamental concepts of the Big Data Analytics which are primarily explored for making automated decisions using machine learning strategies on analyzing large scale structured as well as unstructured data distributed across multiple locations (Map Reduce, Hadoop and No SQL Framework) underscoring the utilitarian importance in current technological context for further exploration leading towards lifelong learning.
DS504C.2	Identify and formulate an engineering problem of analyzing large scale data distributed across multiple locations to make automated meaningful decisions within the scope of Big Data Analytics Frameworks.
DS504C.3	Explore relevant literature and apply the concepts of Big Data Analytics to solve problems of making automated decisions dealing with large scale structured as well as unstructured data using Map Reduce, Hadoop and advanced SQL Frameworks.
DS504C.4	Excogitate ideas for proposing solutions to the challenging problems of Big Data Analytics.
DS504C.5	Implement ideas of Big Data Analytics through developing feasible algorithms or frameworks and investigate their effectiveness in solving the relevant problems by analyzing the performances using proper techniques.

CO-PO-PSO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
DS504C.1	3	2	2	1	-	-	-	-	-	-	-	3	3	2	2
DS504C.2	3	3	3	2	-	-	-	-	-	-	-	3	3	3	2
DS504C.3	3	3	2	3	-	-	-	-	-	-	-	3	3	2	3
DS504C.4	2	3	2	2	-	-	-	-	-	-	-	3	2	2	3
DS504C.5	3	2	2	3	-	-	-	-	-	-	-	3	2	3	3
	2.8	2.6	2.2	2.2	-	-	-	-	-	-	-	3.0	2.6	2.8	2.6

Course Content:

Module – 1: Introduction to Basic Analytics [10L]:
Introduction: Big data overview, Analyst‘s perspective on data repositories, Current analytical architecture, Drivers of big data, Examples of big data analytics. Life Cycle of Data Analytics: Phase 1:

Discovery, Phase 2: Data preparation, Phase 3: Model planning, Phase 4: Model building, Phase 5: Communication of results, Phase 6: Making operational. Basic Analytic Methods: Visualization, Dirty data, Data exploration versus presentation, Statistical methods for evaluation – hypothesis testing, difference of means, rank sum test, type I and type II errors, ANOVA.

Module - 2: Advanced Analytic Methods I [8L]:
Clustering: Overview, K-means, Determining the number of clusters, Diagnostics. Association Rules: Overview, Apriori algorithm, Evaluation of candidate rules, Application of association rules, Validation and testing, Diagnostics. Regression: Linear regression - model description, Logistic regression – model description, Other regression models. Classification: Decision trees – overview, General algorithm, Decision tree algorithms, Evaluating a decision tree, Naïve Bayes – Bayes theorem, Naïve Bayes classifier, Diagnostics of classifiers.

Module – 3: Advanced Analytic Methods II [8L]:
Time Series Analysis: Overview, Box-Jenkins methodology, Autocorrelation function (ACF), Autoregressive model, Moving average model, ARMA and ARIMA model, Building and evaluating an ARIMA model. Text Analysis: Steps in text analysis, Collecting raw text, Representing text, Term Frequency-Inverse Document Frequency (TFIDF), Categorizing documents by types, Determining sentiments. Map Reduce and Hadoop: Analytics for unstructured data – map reduce, Apache Hadoop, Hadoop Ecosystem – Pig, Hive, Hbase, Mahout.

Module – 4: Advanced Analytic Methods III [10L]:
Technology and Tools: SQL essentials - Join, Set, Grouping extensions, Advanced SQL – Window functions, User-defined functions, Ordered aggregates, MADlib, NoSQL. Integration of Techniques: Communicating and operationalizing an analytic project. Creating final deliverables – Developing core materials, project goals, Main findings, Approach, Model description and model details, Recommendations, Providing technical specifications and code. Data visualization basics - Key points, evolution of a graph, common representation methods, how to clean up a graphic.

Text book:

1. EMC Education Services (Editor), Data Science and Big Data Analytics. John Wiley & Sons, 2015.
2. Mike Barlow, Real-Time Big Data Analytics: Emerging Architecture. O'Reilly, 2013.

Reference Books:

1. Nathan Marz and James Warren, Big Data: Principles and Best Practices for Scalable Real-time Data Systems. Manning Publications, 2015.
2. Venkat Ankam, Big Data Analytics. Packt Publishing Ltd., UK, 2016.

Course Title: Business Communication and Value Science
Course Code: HU (DS) 501
Contact Hours/Week (L): 2
Credits: 2
Program: 3rd Year B. Tech (Sem-5)

Pre-requisites: A basic knowledge of English grammar, vocabulary and writing skills and the workplace uses of English.

Course Objectives: By the end of the course the student should be able to

CO1.1	Identify, explain and reproduce Business English vocabulary in context.
CO1.2	Classify, compare and apply Business E-mail and Develop Technical Writing Skills
CO1.3	Read, understand and reproduce technical information in a detailed business report.
CO1.4	Understand and write business start-up proposals.
CO1.5	Understand, identify and apply value Science and Life Skills

Course outcome: To maximize exposure and train students in the professional use of English in the globalized workplace and introduce them to key concepts of values, life skills.

Syllabus: **24 L**

Module 1: Business Communication Basics [4L]

1.1 Communicating in Business—the Workplace; Cross Cultural Communication (Understand and apply the concepts of Global, glocal and translocational)
1.2 Reading and identifying business terms and vocabulary (vocabulary related to business products and processes, buying and selling, consumers, banking and finance)
1.3 Use electronic/social media to share concepts and ideas: advertising, media and the internet (Launching an E Magazine.).

Module 2: Writing Business E-mails; Job Application Letter and Develop Technical Writing Skills [6 L]
2.1 Business E-mails: Functions, Conventions and Modalities
2.2 Writing: Job Application Letter along with CV and Resume
2.3 Writing: Software user manual; pie chart and bar graph analysis

Module 3: Business Reports and [4L]
3.1 Business Reports: Needs and Functions
3.2 Arranging and classifying information
3.3 Report Writing Styles and Rubrics

Module 4: Proposals for Business Start-ups [4L]
4.1 How to Write a Proposal for a Start-up
4.2 Business Proposal Templates
4.3 Proposal Writing Practice

Module 5: Value science and Life Skills in Profession [6L]
5.1 Introduction to the concepts of Values and Ethics
5.2 Understanding Workplace Code of Ethics and Whistle Blowing with case studies
5.4 Understanding and the applying the concepts of CSR (Corporate Social Responsibility)

5.5 Understand the basic concepts of Morality and Diversity
5.6 Self-awareness – identity, body awareness, stress management; introduce students to Self-analysis techniques like SWOT & TOWS

Recommended Books/References:

1. Bill Mascull. *Business Vocabulary in Use*. 3rd Edition. Cambridge: Cambridge University Press, 2010.
2. Ibbotson, Mark and Bryan Stephens. *Business Start-Up.* Cambridge: Cambridge University Press, 2006.
3. Paul Emmerson. *E-mail English*. London: Macmillan, 2013.

CO-PO and PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
HU(EC)501.1	-	-	2	-	-	1	1	-	2	3	-	2	-	-	-
HU(EC)501.2	-	-	2	2	-	3	3	-	2	3	-	3	2	1	1
HU(EC)501.3	-	-	2	2	-	3	3	2	2	3	-	3	2	-	-
HU(EC)501.4	-	-	-	-	-	3	3	2	2	3	-	3	-	-	-
HU(EC)501.5	-	-	-	-	-	3	3	2	2	3	-	3	-	-	-

Course Name: ARTIFICIAL INTELLIGENCE LAB
Course Code: DS591
Contact (Periods/Week):=3P/Week
Total Contact Hours: 36
Credits: 1.5

Pre-requisite:
Data Structure, Design and Analysis of Algorithms, Statistics

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
DS591.1	Acquire foundational knowledge of PROLOG to implement an Artificial Intelligent Agent as an executable computer program for Knowledge Representation and Inferencing and understand the working principle of the agent and assess its utilitarian importance in current technological context leading towards lifelong learning.
DS591.2	Identify and formulate an engineering problem by analyzing its characteristics to fit a State-Space Exploration Framework or an Inferencing Agent Formulation Framework of Artificial Intelligence.
DS591.3	Explore relevant literature and apply the concepts of Artificial Intelligence to solve a problem by implementing well-known Artificial Intelligence strategies using proper techniques and tools of PROLOG.
DS591.4	Develop ideas and propose expert systems offering solutions to the challenging problems of Artificial Intelligence.
DS591.5	Plan and Implement Artificial Intelligence based ideas as executable PROLOG programs through developing intelligent heuristic strategies or expert systems with adequate documentation in collaborative environment for successfully carrying out projects on Artificial Intelligence Problems and investigate their effectiveness by analyzing the performances using proper techniques and tools.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS591.1	3	3	2	2	3	-	-	-	3	-	-	3	3	2	2
DS591.2	3	2	2	3	3	-	-	-	3	-	-	3	3	3	3
DS591.3	3	3	2	2	3	-	-	-	3	-	-	3	3	3	3
DS591.4	3	3	3	3	3	-	-	-	3	-	-	3	3	2	3
DS591.5	3	3	3	3	3	-	-	-	3	-	-	3	3	3	3
	3.0	2.8	2.4	2.6	3.0	-	-	-	3.0	-	-	3.0	3.0	2.6	2.8

Course Content:

WEEK-1: Introduction to PROLOG Programming along with the IDE and its Basic Components:
Assignments for understanding the Basic Components of Knowledge Representation and Inferencing in Artificial Intelligence using PROLOG Programming and its working strategy.

WEEK -2: Arithmetic, Boolean Expression, Decision Making Strategies: Assignments for understanding implementation of Arithmetic Expression, Boolean Expression, and Decision- Making Strategies.

WEEK -3: Recursion and Looping through Recursion: Assignments for understanding implementation of Recursion and Looping through Recursion.

WEEK -4: List of Data Items in PROLOG: Assignments for understanding the utility of List in solving various problems.

WEEK -5: Blind Search Techniques – BFS, DFS: Implementation of BFS and DFS Algorithms for Goal Searching to solve Puzzles (8-Puzzle, Water Jug Puzzle)

WEEK -6: Heuristic Search Techniques – A* Search: Implementation of A* Search Algorithm for Goal Searching to solve Puzzles (8-Puzzle, Route Finding Puzzle).

WEEK-7: Constraint Satisfaction Problem Solving: Implementation of Backtracking Strategies to solve Constraint Satisfaction Problems (Graph Coloring Problem, 8-Queens Problem)**.**

WEEK -8: Game Playing Implementation of Adversarial Search Algorithm with alpha-beta pruning strategy for Game Playing (Tic-Tac- Toe)

WEEK -9: Discussion on Project Problems and Allocation (Problem Description Report Submission)

WEEK -10: Designing Solution Model and Proposal Report Submission

WEEK -11: Project Implementation, Verification and Documentation

WEEK -12: Project Demonstration and Project Report Review

Text book:

1. Ivan Bratko, Prolog Programming for Artificial Intelligence, 4th Edition, Addison-Wesley.
2. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.
3. Rich, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGrawHill.

Reference Books:

1. Padhy, N.P. 2009. Artificial Intelligence and Intelligent Systems, Oxford University Press.
2. Deepak Khemani, ―A First Course in Artificial Intelligence‖, McGraw Hill.

Course Name: DATABASE MANAGEMENT LAB
Course Code: DS592
Contact (Periods/Week): = 3P/Week
Total Contact Hours: 36
Credits: 1.5

Pre-requisite:
1. Logic of programming language
2. Basic concepts of data structure and algorithms

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
DS592.1	To Understand and Describe the basic concepts and utility of Database management system, different data models of Database management system.
DS592.2	To Design an Entity Relationship (E-R) Diagram and relational model for any kind of real-life application and able to Apply relational algebra operations, SQL, Neo4j for solving query.
DS592.3	To Analyze and Create the relational database for any real-life applications based on normalization.
DS592.4	To Apply the query optimization techniques, different file organization techniques and Determine whether the transaction satisfies the ACID properties.
DS592.5	To Implement and organize the database of an organization as a team.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS592.1	3	2	2	2	2	-	-	-	3	-	-	3	3	3	3
DS592.2	3	2	2	2	2	-	-	-	3	-	-	3	3	3	3
DS592.3	3	3	2	2	2	-	-	-	3	-	-	3	3	3	3
DS592.4	3	2	2	2	2	-	-	-	3	-	-	3	3	3	3
DS592.5	3	2	2	2	2	-	-	-	3	-	-	3	3	3	3
	3.0	2.2	2.0	2.0	2.0	-	-	-	3.0	-	-	3.0	3.0	3.0	3.0

Course Content:

Module 1

Conceptual Designing using ER Diagrams (Identifying entities, attributes, keys and relationships between entities, cardinalities, generalization, specialization etc.)

Module 2

Converting ER Model to Relational Model (Represent entities and relationships in Tabular form, Represent attributes as columns, identifying keys) and apply the normalization techniques.

Module 3

Creation of Tables using SQL- Overview of using SQL tool, Data types in SQL, Creating Tables (along with Primary and Foreign keys), Altering Tables and Dropping Tables

Module 4

Practicing DML commands- Insert, Select, Update, Delete

Module 5

Practicing Queries using ANY, ALL, IN, EXISTS, NOT EXISTS, UNION, INTERSECT, CONSTRAINTS etc., Practicing Sub queries (Nested, Correlated) and Joins (Inner, Outer and Equi).

Module 6

Practice Queries using COUNT, SUM, AVG, MAX, MIN, GROUP BY, HAVING, VIEWS Creation and Dropping, Practicing on Triggers - creation of trigger, Insertion using trigger, Deletion using trigger, Updating using trigger.

Module 7

Procedures- Creation of Stored Procedures, Execution of Procedure, and Modification of Procedure, PL/SQL, Cursors- Declaring Cursor, Opening Cursor, Fetching the data, closing the cursor.

Course Name: OBJECT ORIENTED PROGRAMMING USING JAVA LAB
Course Code: IT(DS)591
Contact (Periods/Week):=3P/Week
Total Contact Hours: 36
Credits: 1.5

Pre-requisite:

1. Computer Fundamentals
2. Basic understanding of Computer Programming and related Programming Paradigms
3. Problem Solving Techniques with proper logic Implementation.

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
IT(DS)591.1	Create the procedure of communication between Objects, classes & methods.
IT(DS)591.2	Understand the elementary facts of Object Orientation with various characteristics as well as several aspects of Java.
IT(DS)591.3	Analyze distinct features of different string handling functions with various I/O operations.
IT(DS)591.4	Discuss simple Code Reusability notion w.r.t. Inheritance, Package and Interface.
IT(DS)591.5	Apply Exception handling, Multithreading and Applet (Web program in java) programming concept in Java.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
IT(DS)591.1	3	3	2	3	2	-	-	-	3	-	-	2	3	2	2
IT(DS)591.2	3	3	3	3	2	-	-	-	3	-	-	2	3	2	2
IT(DS)591.3	3	3	3	3	2	-	-	-	3	-	-	2	3	2	3
IT(DS)591.4	3	3	3	3	3	-	-	-	3	-	-	2	3	2	3
IT(DS)591.5	3	3	3	3	3	-	-	-	3	-	-	2	3	3	3
	3.0	3.0	2.8	3.0	2.4	-	-	-	3.0	-	-	2.0	3.0	2.2	2.6

Course Content:

Module 1: Java Basics:

1. Simple Java programming using operators, control statements & loops, array.
2. Programming on class, object, and method, access specifier.
3. Programming on constructor, method/constructor overloading.
4. Programming on this keyword, call by value & call by reference, static variables & methods, inner classes.

Module 2: Basic String handling & I/O:

1. Programming to show the use of String class methods - charAt(), compareTo(), equals(), equalsIgnoreCase(), indexOf(), length() , substring(), toCharArray(), toLowerCase(), toString(), toUpperCase(), trim(), valueOf() methods.
2. Programming to show the use of StringBuffer class methods - append(), capacity(), charAt(), delete(), deleteCharAt(),ensureCapacity(), getChars(), indexOf(), insert(), length(), setCharAt(), setLength(), substring(), toString() methods.
3. Programming on Command line arguments.
4. Programming using keyboard input by implementing BufferedReader& Scanner classes.

Module 3: Inheritance, Interface and Java Packages:

1. Programming on Simple Inheritance, super and final keywords, super() method.
2. Programming on method overriding, dynamic method dispatch,abstract classes & methods, multiple inheritance by using interface.
3. Programming on importing system package, creating user-defined package, importing user-defined package, using protected access specifier, subclassing an imported class of a package, using same names for classes of different packages, adding multiple public classes to a package.

Module 4: Exception handling, Multithreading and Applet Programming:

1. Programming on exception handling using try-catch block, implementing throw and throws keywords, using finally block, creating user-defined exception.
2. Programming on creating child threads i) by extending thread class ii) by implementing runnable interface, creating child threads by assigning thread priorities.
3. Programming on creating simple applet to display some message, creating applet two add 2 integers, creating applet to do GUI based programming.

Textbooks:

1. Herbert Schildt – "Java: The Complete Reference " – 9th Ed. – TMH
2. E. Balagurusamy – " Programming With Java: A Primer " – 3rd Ed. – TMH.

Reference Books:

1. R.K Das – " Core Java for Beginners " – VIKAS PUBLISHING.
2. Rambaugh, James Michael, Blaha – " Object Oriented Modelling and Design " – Prentice Hall, India

3rd Year 6th Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
A. THEORY					L	T	P	Total	
1	ENGG	Major	DS601	Internet and Web Programming	3	0	0	3	3
2	ENGG	Major	DS602	Machine Learning	3	0	0	3	3
3	ENGG	Major	DS603	Business Intelligence and Analytics	3	0	0	3	3
4	ENGG	Major	DS604A	Software Engineering	3	0	0	3	3
			DS604B	Natural Language Processing					
			DS604C	Mobile Computing					
5	ENGG	Major	DS605	Blockchain and Cryptocurrency Technologies	3	0	0	0	3
B. PRACTICAL									
1	ENGG	Major	DS691	Internet and Web Programming Lab	0	0	3	3	1.5
2	ENGG	Major	DS692	Machine Learning Lab	0	0	3	3	1.5
3	ENGG	Major	DS693	Business Intelligence and Analytics Lab	0	0	3	3	1.5
		TOTAL CREDIT							19.5

Course Name: Web and Internet Technology
Course Code: DS601
Contact (Periods/Week): 3L/Week
Credit Point: 3
No. of Lectures: 36

Course Outcomes (COs):
After attending the course students should be able to

CO1	To develop interactive web pages using HTML, DHTML, CSS and image map
CO2	To procure the knowledge of information interchange formats like XML
CO3	To validate fields of web pages using scripting languages like JavaScript
CO4	To develop web applications using PHP and ASP.net
CO5	To acquire the server side programming concepts using servlet, JSP

Course Contents:
Module 1: [6L]
Introduction (1L): Overview, Network of Networks, Intranet, Extranet, and Internet.
World Wide Web (1L): Domain and Sub domain, Address Resolution, DNS, Telnet, FTP, HTTP.
Review of TCP/IP (1L): Features, Segment, Three-Way Handshaking, Flow Control, Error Control, Congestioncontrol, IP Datagram, IPv4 and IPv6.
IP Subnetting and addressing (1L): Classful and Classless Addressing, Subnetting. NAT, IP masquerading, IP tables. Internet Routing Protocol (1L): Routing -Intra and Inter Domain Routing, Unicast and Multicast Routing,Broadcast. Electronic Mail (1L): POP3, SMTP, Clients - Servers Communication.

Module -2: [9L]
HTML, DHTML &CSS : Introduction, Elements, Attributes, Heading, Paragraph. Formatting[1L]; Link, Table, List, Block, Layout, Html Forms, and input [1L]; Iframe, Colors[1L], Image Maps andattributes of image area [1L];
Introduction to CSS, basic syntax and structure of CSS, different typesinternal, external and inline CSS [1L]; Basic Introduction of DHTML, Difference between HTMLand DHTML, Documentary Object Model (DOM)[1L].
Extended Markup Language (XML) : Introduction, Difference between HTML & XML,XML-Tree [1L]; Syntax, Elements, Attributes, Validation and parsing, DTD [2L].

Module 3: [15L]
Java Scripts: Basic Introduction, Statements, comments, variable, operators, data types[1L];condition, switch,loop, break [1L]; Java script functions, objects, and events[1L].
CGI Scripts: Introduction, Environment Variable, GET and POST Methods[1L].
Java Servlet: Servlet environment and role, Servlet life cycle [1L]; Servlet methods- Request,Response, Get andpost [1L]; Cookies and Session [1L].
Java Server Page (JSP):
JSP Architecture [1L]; JSP Servers, JSP Life Cycle [1L]; Understanding the layout of JSP, JSP
Scriptlet Tag [1L]; JSP implicit object (request and response) [1L]; Variable declaration, methodsin JSP [1L]; JSP directive (Taglib and Include), JavaBean- inserting JavaBean in JSP [1L]; JSPAction tags (Forward & Include) [1L]; Creating ODBC data source name, Introduction to JDBC,prepared statement and callable statement [1L].

Module-4: [6L]
Threats [1L]: Malicious code-viruses, Trojan horses, worms; eavesdropping, spoofing, modification, denial

ofservice attacks.
Network security techniques: Password and Authentication; VPN, IP Security[1L], security in electronic transaction, Secure Socket Layer (SSL), Secure Shell (SSH)[1L].
Firewall (1L): Introduction, Packet filtering, Stateful, Application layer, Proxy.
Search Engine and Web Crawler: Definition, Meta data, Web Crawler[1L], Indexing, Page rank, overview ofSEO[1L].

Textbooks:

-Web Technology: A Developer's Perspective‖, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013. (Topics covered: html, CSS, imagemap, xml)
-Learning PHP, MySQL & JavaScript‖, Robin Nixon, O'Reilly Publication. (Topics covered:Java Script)
-Head First Servlet's & JSP‖, Bryan Basham, Kathy Sterra, Bert Bates, O'Reilly Publication. (Topics covered: Servlet, JSP)
Cryptography and Network Security by William Stallings Publisher: Pearson Education India(Topics covered: Threats, Security techniques, Firewall)

Recommended books:

"Programming the World Wide Web", Robert. W. Sebesta, Fourth Edition, Pearson Education,2007.
-Core Web Programming‖- Second Edition-Volume I and II, Marty Hall and Larry Brown, Pearson Education, 2001

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3				2			3
CO2	3	3	3	3	3				2			3
CO3	3	3	3	3	3				2			3
CO4	3	3	3	3	3				2			3
CO5	3	3	3	3	3				2			3

CO-PSO Mapping

Cos	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Machine Learning

Course Code: DS602
Contact (Periods/Week): 3L/Week
Credit Point: 3
No. of Lectures: 36

Prerequisite:

1. Basic programming skills, Algorithm design.
2. Probability, Axioms of Probability, Conditional Probability, Bernoulli Distribution, Binomial Distribution, Multinomial Distribution, Uniform Distribution, Normal (Gaussian) Distribution, Chi-Square Distribution, t Distribution, F Distribution. Probability Distribution and Density Functions, Joint Distribution and Density Functions, Conditional Distributions, Bayes' Rule, Expectation, Variance, Weak Law of Large Numbers.
3. Linear Algebra; Convex Optimization ; Statistics; Calculus.

Course Outcomes (COs):

After attending the course students should be able to

CO1	Understand the fundamental concepts of basics of machine learning to Explain or Illustrate and Identify problems where students can Apply the concept appropriatelyto Solve them.
CO2	Understand the fundamental concepts of regression problems so that they canpropose models for predicting values based on exemplary data and Analyze their performances.
CO3	Explain or Illustrate the fundamental strategies of unsupervised machine learningparadigm to solve clustering problems and Analyze their performances.
CO4	Explain or Illustrate the concepts of Mining Frequent Patterns, Associations and DataStreams and Apply them to solve the relevant problems and Analyse their performances.
CO5	Develop ideas to Propose solutions to the problems of supervised learning and Identify problems where students can Apply the concept appropriately and Analyze the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content

Module 1: [8L]
Supervised Learning (Regression/Classification) Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes Linear models: Linear Regression, Logistic Regression, Generalized Linear Models Support Vector Machines, Nonlinearity and Kernel Methods Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Module 2:[5L]

Unsupervised Learning Clustering: K-means/Kernel K-means Dimensionality Reduction: PCA and kernel PCA Matrix Factorization and Matrix Completion Generative Models (mixture models and latent factor

models)

Module 3:[4L]
Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Module 4: [7L]
Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

Module 5: [7L]
Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

Module6: [4L]
Recent trends in various learning techniques of machine learning and classification methods.

Text Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer

Reference Books:

1. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
2. Dr. Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3							3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	3	3	3	3	3							3

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Business Intelligence and Data Analytics
Course Code: DS603
Contact (L: T: P): 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:
Students are required to possess a fundamental understanding of the Python programming language.

Course Objectives:
- The purpose of this course is to establish a strong groundwork in the field of business analytics.
- The course is structured to offer comprehensive understanding in machine learning and statistical techniques for effective data analysis.
- Furthermore, students will gain proficiency in utilizing the Python programming language for implementing machine learning algorithms, and in using both Python and R for statistical methodologies.
- An abridged introduction to neural networks and deep learning concepts will also be included in the curriculum.

Course Outcomes (COs):
CO-1: Comprehend Business Intelligence Concepts: Understand the fundamental concepts of business intelligence, including data warehousing, data mining, and data visualization, and their role in aiding decision-making processes within organizations.
CO-2. Apply Data Analytics Techniques: Apply various data analytics techniques, such as descriptive, predictive, and prescriptive analytics, to analyse complex business data sets, extract valuable insights, and make informed decisions.
CO-3. Utilize Data Visualization Tools: Demonstrate proficiency in using data visualization tools and software to create clear and compelling visual representations of data, enabling effective communication of insights to both technical and non-technical stakeholders.
CO-4. Implement Business Intelligence Solutions: Develop the ability to design and implement business intelligence solutions, including designing data models, developing dashboards, and creating interactive reports to support strategic planning and operational efficiency.
CO-5. Ethical and Legal Considerations: Understand the ethical and legal implications related to data collection, storage, and analysis. Develop the skills to ensure compliance with relevant regulations and guidelines while handling sensitive business data.

CO-PO/PSO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	3	3	2	2									3	3	3
CO 2	3	2	3	2									3	3	3
CO 3	2	2	2	3									3	3	3
CO 4	3	3	3	3									3	3	3
CO 5	3	2	3	3									3	3	3

Course Content:
Module 1: An Overview of Business Intelligence [6L]
- Introduction to Business Intelligence and its significance.
- Analytics and Decision Support: Role of analytics in decision-making.
- Framework for Business Intelligence (BI): Components, architecture, and processes.

- Intelligence Creation and Use in BI: Gathering, processing, and utilizing intelligence.
- Governance and Ethics in BI: Responsible data usage and compliance.
- Transaction Processing vs. Analytic Processing: Contrasting operational and analytical data processing.
- Successful BI Implementation: Factors for effective BI initiatives.
- Analytics Overview: Introduction to analytics concepts and relevance.
- Brief Introduction to Big Data Analytics: Basics of big data and its analytics.

Module 2: Foundation of Data Analytics [6L]

- Introduction to Data Analytics: Evolution, scope, and concepts.
- Data and Big Data: Types, characteristics, and introduction to big data.
- Metrics and Data Classification: Measures, classification of data.
- Data Reliability & Validity: Ensuring data quality and accuracy.
- Problem Solving with Analytics: Applying analytics for business solutions.
- Phases of Analytics: Descriptive, Predictive, and Prescriptive Analytics.
- Applications of Analytics in Business: Real-world applications of analytics.
- Text Analytics and Web Analytics: Exploring text and web analytics.
- Skills for Business Analytics: Essential competencies for effective analytics.
- Concepts of Data Science: Introduction to data science and its significance.
- Basic Skills for Understanding Data Science: Foundational skills for comprehending data science.

Module 3: Data Warehousing [6L]

- Data Warehousing Process Overview: Phases and processes in data warehousing.
- Data Warehousing Architectures: Different architectural approaches.
- Data Integration and ETL Processes: Extraction, Transformation, Load processes for data integration.
- Data Warehouse Development: Steps in building a data warehouse.
- Data Warehousing Implementation Issues: Challenges in data warehousing.
- Real-Time Data Warehousing: Implementing data warehouses for real-time insights.
- Data Warehouse Administration and Security: Managing data warehouses and ensuring security.
- Future Trends in Data Warehousing: Emerging trends in data warehousing.

Module 4: Business Reporting, Visual Analytics, and Business Performance Management [8L]

- Business Reporting and Data Visualization: Concepts and techniques.
- Different Types of Charts and Graphs: Introduction to visualization methods.
- Performance Dashboards: Creating interactive dashboards for monitoring.
- Business Performance Management: Importance and concepts.
- Performance Measurement: Metrics and measurement techniques.
- Balanced Scorecards: Introduction to balanced scorecards.
- Six Sigma as a Performance Measurement System: Implementing Six Sigma in performance management.

Module 5: Data Mining, Text and Web Analytics, Big Data and Analytics, Emerging Trends, Advanced Charts, Demand Forecasting [10L]

- Data Mining Concepts and Applications: Introduction to data mining and its applications.
- Text Analytics and Text Mining: Extracting insights from textual data.
- Sentiment Analysis and Web Mining: Analyzing sentiment and web usage.
- Big Data and Analytics: Defining big data, technologies, and analytics.
- Location-Based Analytics and Consumer Analytics: Utilizing analytics for location and consumer data.
- Recommendation Engines and Web 2.0 Revolution: Leveraging recommendation engines and web trends.
- Cloud Computing and BI: Cloud's impact on BI and data analytics.
- Issues of Legality, Privacy, and Ethics: Ethical considerations in analytics.

- Advanced Charts and Dashboards: Creating advanced visualizations and dashboards.
- Demand Forecasting: Utilizing predictive modeling for business forecasting.
- Emerging Trends and Impacts: Exploring emerging trends and implications of analytics.

Recommended Text Books

5. Business Intelligence: A Managerial Approach (2011) Turban, Sharda, Delen, King, Publisher: Prentice Hall, Edition: 2nd, ISBN: 13-978-0-136
6. Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications by Larissa T. Moss

Recommended Reference Books

1. The Visual Display of Quantitative Information by Edward R. Tufte
2. Business Intelligence: Making Better Decisions Faster by Elizabeth Vitt, Michael Luckevich, Stacia Misner
3. Business Intelligence Competency Centers: A Team Approach to Maximizing, Competitive Advantage (Hardcover)by Gloria J. Miller

Course Name: Software Engineering

Course Code: DS604A
Contact: 3:0:0
Total Contact Hours: 36Credits: 3

Prerequisites:
Programming for Problem Solving

Course Outcomes (COs):
After attending the course students should be able to

CO1	Understand the basic concept of Software Engineering and mathematical knowledge and apply them in designing solution to engineering problem including the specification, design, implementation, and testing of software systems that meet specification, performance,maintenance and quality requirements
CO2	Analyze, elicit and specify software requirements through a productive working relationshipwith various stakeholders of the project
CO3	Design applicable solutions in one or more application domains using software engineeringapproaches that integrates ethical, social, legal and economic concerns.
CO4	Develop the code from the design and effectively apply relevant standards and performtesting, and quality management and practice team work.
CO5	Identify and Use modern engineering tools necessary for software project management timemanagement and software reuse, and an ability to engage in life-long learning.

Course Content:
Module-1:[6L]
Introduction: Software Engineering, Characteristics, Components, Application, Definitions. Software Project Planning-Feasibility Analysis, Technical Feasibility, Cost-Benefit Analysis, Basics of estimation : COCOMO(Basic, intermediate, Complete) model.

Module- 2: [6L]
Evolution and impact of Software engineering, software life cycle models: Waterfall, prototyping, Evolutionary, and Spiral models. Feasibility study, Functional and Non-functional requirements, Requirements gathering, Requirements analysis and specification.

Module -3:[8L]
Basic issues in software design, modularity, cohesion, coupling and layering, function-oriented software design: DFD and Structure chart, object modeling using UML, Object-oriented software development, user interface design. Coding standards and Code review techniques.

Module -4:[7L]
Fundamentals of testing, White-box, and black-box testing, Test coverage analysis and test case design techniques, mutation testing, Static and dynamic analysis, Software reliability metrics, reliability growth modeling.

Module -5: [9L]
Software project management, Project planning and control, cost estimation, project scheduling using PERT and GANTT charts, cost-time relations: Rayleigh-Norden results, quality management, ISO and SEI CMMI, PSP and Six Sigma. Computer aided software engineering, software maintenance, software reuse, Component- based software development.

Text Books:
Fundamentals of Software Engineering by Rajib Mall, –PHI-3rd Edition, 2009.
Software Engineering- Pankaj Jalote(Wiley-India)

Reference Books:
Software Engineering – AgarwalandAgarwal(PHI)
Software Engineering, by Ian Sommerville, Pearson Education Inc., New Delhi, (2009).
Software Engineering: A Practitioner‟s Approach‖, by Roger S. Pressman, McGraw-Hill.(2005)

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2								3
CO2	3	3	3	2								3
CO3	3	3	3	2								3
CO4	3	3	3	2								3
CO5	3	3	3	2								3

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Natural Language Processing
Course Code: DS604B
Contact (Periods/Week): 3L/Week
Credit Point: 3
No. of Lectures: 35

Prerequisite:
Solid background in Linear algebra, Probability and Statistics, Artificial Intelligence and Neural Networks. Good Exposure of Python packages.

Course Outcomes (COs):
After attending the course students should be able to

CO1	Analyze and apply the morality and method of Human Languages such as English and other IndianLanguages using computers.
CO2	Understand the semantics and pragmatics of English language for text processing
CO3	Create CORPUS linguistics based on digestive approach (Text Corpus method)
CO4	Illustrate, analyze and apply for the modern techniques for statistical approaches to machine translation.
CO5	Analyze and apply the POS tagging for a given natural language and select a suitable language modelingtechnique based on the structure of the language.

Module 1: Natural Language Processing Basics 8L
What is Natural Language Processing? Different Phases of Natural Language Processing; Linguistics: Language Syntax and Structure, Words, Phrases, Clauses, Grammar, Dependency Grammar, Constituency Grammar, Word-Order Typology; Lemmas and Word forms, Homonyms, Homographs and Homophones, Heteronyms and Heterographs, Polysemes, Capitonyms, Synonyms and Antonyms, Hyponyms and Hypernyms, Stemming and Lemmatization; Representation of Semantics; Text Corpora: Corpora Annotation and Utilities, Accessing Popular Corpora; Parts of Speech Tagging: Training and Building POS Taggers; HMM Part-of-Speech Tagging; NER-Tagging; Relationship Extraction, Temporal Information Extraction, Event Extraction, Template Filling; Conditional Random Fields (CRFs); Shallow Parsing, Chunking; Building Dependency and Constituency Parsers, Application of NLP.

Module 2: Feature Engineering for Text Representation 9L
Pre-processing the Text Corpus;N-gram Language Models, Smoothing; Traditional Feature Engineering Models; Extracting Features for New Documents; Topic Models in Gensim, LDA, LSI, Hierarchical Dirichlet process; Advanced Feature Engineering Models, Word Embedding, Word2Vec Model, The Continuous Bag of Words (CBOW) Model, The Skip-Gram Model; Semantic Analysis: Exploring WordNet, Understanding Synsets, Analyzing Lexical Semantic Relationships, Semantic Relationships and Similarity, Word Sense Disambiguation.

Module 3: Clustering and Classifying Text 9L
Clustering text: Text Similarity, Analyzing Term Similarity, Analyzing Document Similarity; Classifying text: Classification Models, Evaluating Classification Models, Building and Evaluating of the Text Classifier;Sentiment Analysis: Text Pre-processing and Normalization, Unsupervised Lexicon-Based Models, Classifying Sentiment with Supervised Learning, Text Summarization, Question & Answering

Module 4: Deep Learning Architectures for Sequence Processing 9L
Language Models Revisited; Getting words in order with convolutional neural networks (CNNs), Recurrent Neural Networks, Stacked and Bidirectional RNNs; LSTMs and GRUs; Attention, Transformers;Encoder-

Decoder Model, Machine Translation; Beam Search; Text Classification using CNNs and LSTM; Chatbots

Text Books:

Bhargav Srinivasa-Desikan, –Natural Language Processing and Computational Linguistics", Packt Publishing
Dipanjan Sarkar, –Text Analytics with Python",Apress,ISBN-13 (pbk): 978-1-4842-4353-4
Daniel Jurafsky, James H. Martin, "Speech and Language Processing", Pearson Education India,Third Edition.
Sumit Raj, "Building Chatbots with Python",Apress,ISBN-13 (pbk): 978-1-4842-4095-3

Reference Books:

Francois Chollet, ―Deep Learning with Python‖, Manning Publications; 1st edition
Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, and Harshit Surana, "Practical Natural Language Processing", OReily
Hobson Lane, Cole Howard, Hannes Max Hapke, "Natural Language Processing in Action", Manning Publications

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								
CO2	3	3	3	3								
CO3	3	3	3	3								
CO4	3	3	3	3								
CO5	3	3	3	3								

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Mobile Computing
Course Code: DS604C
Contact: =3L/Week
Credit Point: 3
No. of Lectures: 36

Prerequisite:
Basic concept of computer network and communication engineering
Basic programming knowledge

Course Outcomes (COs):
After attending the course students should be able to

CO1	Illustrate the concepts and working of modern communication technologies.
CO2	Demonstrate the various routing algorithms for both infrastructure based and ad hoc networks.
CO3	Develop mobility and bandwidth management in cellular network
CO4	Design and build an energy efficient and secure mobile computing environment using heterogeneouswireless technologies
CO5	Predict the technical issues related to recent mobile computing environment.

Course Content:
Module 1: Introduction [6L]:
Evolution of different types of wireless communication devices; Effects of mobility of devices; Cellular mobile networks – mobility management (call setup, handoff, interoperability and internetworking), bandwidth management, energy management, security; Brief introduction about different generations of wireless communication technology – 1G, 2G, 3G, 4G, 5G.

Module 2: Mobile Data Communication [5L]
Mobile Data Communication, WLANs (Wireless LANs) IEEE 802.11 standard, Bluetooth technology, Bluetooth Protocols, Ad hoc networks initialization, leader election, location identification, communication protocols, energy and security.

Module 3: Mobility Management in Cellular Networks [4L]
Call setup in PLMN (location update, paging), GPRS, Call setup in mobile IP networks; Handoff management; Mobility models- random walk, random waypoint, Brownian, map-based, group-based.

Module 4: Bandwidth Management in Cellular Mobile networks [3L]
Mathematical formulation of the channel assignment problem (CAP); CAP and generalized graph coloring; Benchmark instances; Lower bound on bandwidth, Genetic algorithms for channel assignment- concept of critical block in a hexagonal cellular network, coalesced CAP, fast near-minimal channel assignment algorithm..

Module 5: Localization of Nodes in a Mobile Network [4L]
Different approaches, Indoor and outdoor localizations, LOS and NLOS signals, Outdoor localization techniques – triangulation (TOA-based, AOA- based), errors due to inaccuracies in coordinates of beacon nodes and in measurements, selection of beacon nodes; Location region identification- computational geometrictechnique.

Module 6: Message Communication in Ad Hoc Networks [6L]

Collision avoidance mechanism (different schemes for a deterministic transmission schedule), collision resolution mechanism – successive partitioning approach; Time slot assignment based on location information, Point-to-point routing in ad hoc networks – proactive, reactive and hybrid approaches, different protocols - DSDV, DSR, AODV, TORA, ZRP

Module 7: Energy-efficient Communication [3L]
Energy efficiency at various layers - Physical layer, MAC layer, Network layer, Application layer, performance analysis in noisy channel environment.

Module 8: Secure Wireless Communication [4L]
Introduction-different types of attacks, internal attacks, external attacks; measures against attacks (authentication, intrusion detection, encryption); RC4 algorithm, Lightweight cryptographic algorithms; antijamming techniques.

Text books:
K. Sinha, S.Ghosh and B. P. Sinha, Wireless Networks and Mobile Computing. CRC Press : New York, 2015.
J. Schiller, Mobile Communication, Pearson
Yi-Bing Lin & Imrich Chlamtac, Wireless and Mobile Networks Architectures, John Wiley & Sons, 2001
Raj Pandya, Mobile and Personal Communication systems and services, Prentice Hall of India, 2001
5. XiangYang Li, Wireless Adhoc and Sensor Networks, Cambridge University Press.
Recommended books:
Research articles published on secure wireless communication (authentication, mitigation of DoS, DDoS, eavesdropping) published in leading journals.
Mark Ciampa, Guide to Designing and Implementing wireless LANs, Thomson learning, Vikas Publishing House, 2001.
P.Stavronlakis, Third Generation Mobile Telecommunication systems, Springer Publishers.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								
CO2	3	3	3	3								
CO3	3	3	3	3								
CO4	3	3	3	3								
CO5	3	3	3	3								

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	2	3	3
CO4	3	3	2
CO5	3	3	3

Course Name: Web and Internet Technology Lab
Course Code: DS691
Contact (Periods/Week): 3P/Week
Credit Point: 2
No. of Lectures: 30

Prerequisite:
Fundamentals of Programming

Course Outcomes (COs):
After attending the course students should be able to

CO1	To develop interactive web pages using HTML, DHTML, CSS and image map
CO2	To procure the knowledge of information interchange formats like XML
CO3	To validate fields of web pages using scripting languages like JavaScript
CO4	To develop web applications using PHP and ASP.net
CO5	To acquire the server side programming concepts using servlet, JSP

List of Experiments:

1. Write a single html program through which you can explain a) anchor tag, b)‘img‘ tag with ‗src‘attribute, c)paragraph d) heading.
2. Write a single html program through which you can draw a table which consists of 3 row and 4columns where 1st row contains 4 different column fields of a student‘s information with red textcolor and Calibri font style with font 12. Rest cells of whole table contain values with blue text colorsand Times new roman font style with font 10.
3. Write a single html program where 1st paragraph can collect its specified style from internal stylesheet describes inside that html program and 2nd paragraph can collect its specified style fromanother file (external stylesheet).
4. Write a single html program which implements image map concept using ‗usemap‘ and <map>.
5. Write a html program to find out Celsius temperature of a given Fahrenheit temperature usingJavaScript.
6. Write a xml parsing technique through which parse a text string into an XML DOM object andextracts theinfo from it with JavaScript.
7. Write a html program to find out m to the power n (m, n valid integer no) using a function usingJavaScript.
8. Write a simple java script program to print the weekday and time.
9. Write a simple java script program to implement the function using the argument and no argument both.
10. Write a simple program in ASP.net through which you can create a login page of your own website.
11. Write a simple JSP program through which you can print even and odd no separately within agiven range.
12. Create an Online Registration form for individual user of an website using Servlet.

Textbooks:

–Web Technology: A Developer's Perspective‖, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013. (Topics covered: html, CSS, imagemap, xml)
–Learning PHP, MySQL & JavaScript‖, Robin Nixon, O'Reilly Publication.(Topics covered:Java Script)
–Head First Servlet's & JSP‖, Bryan Basham, Kathy Sterra, Bert Bates, O'ReillyPublication. (Topics covered: Servlet, JSP)

Recommended books:
"Programming the World Wide Web", Robert. W. Sebesta, Fourth Edition, Pearson Education,2007.
–Core Web Programming‖- Second Edition-Volume I and II, Marty Hall and Larry Brown, Pearson Education, 2001.
–Web Technologies‖, Black Book, Dreamtech Press

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3				2			3
CO2	3	3	3	3	3				2			3
CO3	3	3	3	3	3				2			3
CO4	3	3	3	3	3				2			3
CO5	3	3	3	3	3				2			3

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Machine Learning Lab
Course Code: DS692
Contact: 0:0:3
Total Contact Hours: 36Credits: 1.5

Prerequisite: Familiarity with JAVA/ Python Programming

Course Outcomes (COs):
After attending the course students should be able to

CO1	Understand the fundamental concepts of basics of machine learning to Explain or Illustrate and Identify problems where students can Apply the concept appropriatelyto Solve them.
CO2	Understand the fundamental concepts of regression problems so that they can propose models for predicting values based on exemplary data and Analyze their performances.
CO3	Explain or Illustrate the fundamental strategies of unsupervised machine learningparadigm to solve clustering problems and Analyze their performances.
CO4	Explain or Illustrate the concepts of Mining Frequent Patterns, Associations and Data Streams and Apply them to solve the relevant problems and Analyse their performances.
CO5	Develop ideas to Propose solutions to the problems of supervised learning and Identify problems where students can Apply the concept appropriately and Analyze the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

List of Lab Experiments:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate- Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
5. Write a program to implement the naÔve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6. Assuming a set of documents that need to be classified, use the naÔve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. Youcan add Java/Python ML library classes/API in the program.
9. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correctand wrong predictions. Java/Python ML library classes can be used for this problem.
10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Selectappropriate data set for your experiment and draw graphs.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3							3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	3	3	3	3	3							3

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Business Intelligence and Data Analytics Lab
Course Code: DS693
Contact (L: T: P): 0:0:3
Total Contact Hours: 36
Credit: 1.5

Prerequisites:
Basic knowledge on Python Programming

Course Objectives:
To provide hands-on experience in applying data analysis techniques and utilizing business intelligence tools to extract actionable insights from diverse datasets.

Course Outcomes (COs):
CO1: Data Analysis Proficiency: Gain the ability to perform data preprocessing, exploratory analysis, and statistical interpretation on real-world datasets.
CO2: Business Intelligence Application: Develop skills in creating interactive dashboards and reports using business intelligence tools to visually present analytical findings.
CO3: Effective Visualization: Acquire proficiency in designing and generating meaningful visualizations to communicate insights and trends derived from data.
CO4: Data-Driven Decision-Making: Learn to use data analytics to support informed decision-making processes across various business scenarios.
CO5: Hands-On Experience: Apply learned concepts through practical exercises, enabling the application of data analytics techniques in real-world contexts.

CO-PO/PSO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
C01	3	2	2	2									3	3	3
CO 2	3	3	3	2									3	3	3
CO 3	2	3	2	2									3	3	3
CO 4	3	3	3	3									3	3	3
CO 5	3	2	3	3									3	3	3

Course Content:
1: Introduction to Data Analytics and Tools
- Understanding the role of data analytics in business
- Introduction to tools like Python and Jupyter Notebook
- Setting up the development environment and libraries

2: Data Preprocessing and Cleaning
- Loading datasets from different sources (CSV, Excel)
- Handling missing values and outliers
- Data transformation techniques

3: Exploratory Data Analysis (EDA)
- Generating descriptive statistics and visualizations
- Creating histograms, scatter plots, and correlation matrices
- Identifying patterns and trends through EDA

4: Data Visualization Techniques
- Introduction to data visualization libraries (Matplotlib, Seaborn)
- Creating line charts, bar plots, and heatmaps
- Design principles for effective data visualizations

5: Introduction to SQL for Data Analysis
- Basics of SQL queries and relational databases
- Retrieving and filtering data using SELECT statements
- Joining tables for comprehensive analysis

6: Descriptive and Predictive Analytics
- Calculating measures of central tendency and dispersion
- Applying linear regression for predictive modeling
- Evaluating model performance using metrics

7: Clustering and Segmentation
- Understanding clustering algorithms (K-Means)
- Grouping similar data points using clustering techniques
- Visualizing clusters and interpreting results

8: Time Series Analysis
- Introduction to time series data and its characteristics
- Time series visualization and trend analysis
- Basic forecasting using moving averages and exponential smoothing

9: Introduction to Business Intelligence (BI)
- Overview of BI concepts and applications
- Role of BI in decision-making processes
- Understanding key BI tools and platforms

10: Creating Interactive Dashboards
- Building basic dashboards using BI tools (e.g., Tableau)
- Adding visualizations, filters, and interactions
- Designing dashboards for specific business scenarios

11: Advanced Analytics in Business Intelligence
- Incorporating predictive analytics within BI platforms
- Applying machine learning algorithms for insights
- Demonstrating advanced visualizations in BI

12: Data Ethics and Privacy
- Understanding ethical considerations in data analytics
- Privacy concerns and regulatory compliance
- Ensuring responsible data handling and usage

13: Cloud-based Analytics and Future Trends
- Exploring cloud platforms for data storage and analysis
- Understanding the benefits and challenges of cloud-based BI
- Discussing emerging trends in BI and data analytics

14: Final Project Presentation and Assessment
- Students present their comprehensive data analytics projects
- Demonstrating data analysis, visualizations, and findings
- Assessment based on project quality, understanding, and presentation

Recommended Text Books:

"Data Science for Business" by Foster Provost and Tom Fawcett

"Business Intelligence Guidebook" by Rick Sherman

Recommended Reference Books:

"Python for Data Analysis" by Wes McKinney

4th Year 7th Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
		A. THEORY			L	T	P	Total	
1	ENGG	Major	DS701	Neural Networks and Deep Learning	3	0	0	3	3
2	ENGG	Major	DS702A	Advanced Algorithms	3	0	0	3	3
			DS702B	Decision Support Systems and Intelligent Systems					
			DS702C	Parallel and Distributed Computing					
3	ENGG	Major	DS703A	Information Theory and Coding	3	0	0	3	3
			DS703B	Sensor Networks and IoT					
			DS703C	Data Mining and Data Warehouse					
4	ENGG	Minor	CS(DS)701A	Time Series Analysis and Forecasting	3	0	0	3	3
			CS(DS)701B	Image Processing					
			M(DS)701C	Optimization Techniques					
		B. PRACTICAL							
1	ENGG	Major	DS791	Neural Networks and Deep Learning Lab	0	0	3	3	1.5
2	ENGG	Major	DS792A	Advanced Algorithms Lab	0	0	3	3	1.5
			DS792B	Decision Support Systems and Intelligent Systems					
			DS792C	Parallel and Distributed Computing Lab					
3	ENGG	Major	DS793A	Information Theory and Coding Lab	0	0	3	3	1.5
			DS793B	Sensor Networks and IoT Lab					
			DS793C	Data Mining and Data Warehouse Lab					
4	ENGG	Minor	CS(DS)791A	Time Series Analysis and Forecasting Lab	0	0	3	3	1.5
			CS(DS)791B	Image Processing Lab					
			M(DS)791C	Optimization Techniques Lab					
5	PRJ	Project	DS781	Project	0	0	8	8	4
TOTAL CREDIT									22

Course Name: Neural Network and Deep Learning
Paper Code:DS701
Contact (L: T: P): 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

AI, Machine learning, Python.

Course Objectives:

To understand the basics in deep neural networks

• To understand the basics of associative memory and unsupervised learning networks

• To apply CNN architectures of deep neural networks

• To analyze the key computations underlying deep learning, then use them to build and train deep neural networks for various tasks.

• To apply auto encoders and generative models for suitable applications.

Course Outcomes (COs):

On successful completion of the course, the students will be able to:

CO1	Apply Convolution Neural Network for image processing.
CO2	Understand the basics of associative memory and unsupervised learning networks.
CO3	Apply CNN and its variants for suitable applications.
CO4	Analyze the key computations underlying deep learning and use them to build and train deep neural networks for various tasks.
CO5	Apply auto encoders and generative models for suitable applications.

CO-PO/PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	2	-	-	-	-	-	-	-	3	2	-
CO2	3	2	3	3	-	-	-	-	-	-	-	-	3	2	-
CO3	3	3	3	3	2	-	-	-	-	-	-	-	2	2	2
CO4	3	2	3	3	2	-	-	-	-	-	-	-	3	2	-
CO5	3	3	3	3	2	-	-	-	-	-	-	-	3	2	-

Course Content:

Module-1- Introduction **6L**

Neural Networks-Application Scope of Neural Networks-Artificial Neural Network: An Introduction- Evolution of Neural Networks-Basic Models of Artificial Neural Network- Important Terminologies of ANNs-Supervised Learning Network.

Module-2: **8L**

Training Algorithms for Pattern Association-Auto associative Memory Network-Hetero associative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Iterative Autoassociative Memory Networks-Temporal Associative Memory Network-Fixed Weight

Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Counter propagation Networks-Adaptive Resonance Theory Network.

Module-3 **8L**

ASSOCIATIVE MEMORY AND UNSUPERVISED LEARNING NETWORKS

Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Neuroscientific Basis – Applications: Computer Vision, Image Generation, Image Compression.

Module-4: **8L**

THIRD-GENERATION NEURAL NETWORKS

History of Deep Learning- A Probabilistic Theory of Deep Learning- Gradient Learning – Chain Rule and Backpropagation - Regularization: Dataset Augmentation – Noise Robustness -Early Stopping, Bagging and Dropout - batch normalization- VC Dimension and Neural Nets.

Module-5: **6L**

DEEP FEEDFORWARD NETWORKS

Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Applications: Image Generation, Image Compression, Natural Language Processing. Complete Auto encoder, Regularized Autoencoder, Stochastic Encoders and Decoders, Contractive Encoders.

Recommended Text Books

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016. 2. Francois Chollet, “Deep Learning with Python”, Second Edition, Manning Publications, 2021

Recommended Reference Books

1. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, Oreilly, 2018.
2. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O’Reilly Media, 2017.
3. Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook”, Springer International Publishing, 1st Edition, 2018.
4. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
5. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020

Course Name: Advanced Algorithms
Course Code: DS702A
Contact: 3:0:0
Total Contact Hours: 36Credits: 3

Prerequisites: Design & Analysis of Algorithm

Course Outcomes (COs):
After attending the course students should be able to

CO1	To understand and illustrate the concepts of time and space complexity, worst case,average case and best-case complexities and the asymptotic notation.
CO2	To analyze and apply the design principles and concepts to various basic algorithmdesign viz. dynamic programming, greedy method etc.
CO3	To understand and analyze various string matching and graph algorithms.
CO4	To understand, illustrate and analyze the different complexity classes
CO5	To discuss, implement and analyze, verify the efficiency of the randomized andapproximation algorithms.

Course Content:
Module-1 [4L]Sorting:
Review of various sorting algorithms, topological sorting
Graph: Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), DFS and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

Module-2
[6L] Matroids:
Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.Graph Matching: Algorithm to compute maximum matching.Characterization of maximum matching by augmenting paths,Edmond's Blossom algorithm to compute augmenting path.

Module-3 [16L]Flow- Networks:
Maxflow-Mincut Theorem, Ford Fulkerson Method to compute Maximum Flow, Edmond-Karp maximum-flowalgorithm. Matrix Computations: Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm.More examples of dynamicprogramming.
Modulo Representation of integers/ polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation.Extension to polynomials. Application: Interpolation problem.
Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring.Fast Fourier Transform algorithm. Schonhage-Strassen **IntegerMultiplication algorithm**
Amortized Analysis: Aggregate, Accounting, and Potential Method

Module-4[10L] Linear Programming:
Geometry of the feasibility region and Simplex algorithm
NP-completeness: Examples, proof of NP-hardness and NP-completeness. One or more of the following topics based on time and interest Approximation algorithms, Randomized Algorithms, Interior Point Method, Advanced Number Theoretic Algorithm Problem Solving Application
Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying

recently proposed data structures.

Textbook:
"Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
"The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman. 3. "Algorithm Design"by Kleinberg and Tardos. 4. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House, New Delhi

Reference Books:
"Algorithm Design" by Kleinberg and Tardos.
Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House, New Delhi

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2								2
CO2	3	3	3	3								2
CO3	3	3	3	3								2
CO4	3	3	3	3								2
CO5	3	3	3	3								2

CO-PSO Mapping

Cos	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Decision Support Systems and Intelligent Systems
Paper Code: DS702B
Contact (L: T: P): 3 0 0
Total Contact Hours: 36
Credit: 3

Prerequisites: Knowledge of Database Systems, Data Analysis, and Programming will be helpful.

Course Objectives: The objective of the course is to make the students able to -

1. Understand the theoretical foundations of Decision Support Systems (DSS) and Intelligent Systems (IS).
2. Learn to design and develop decision support systems for solving complex business problems.
3. Explore various intelligent techniques and their applications in decision-making processes.
4. Gain practical experience in implementing DSS and IS solutions for real-world scenarios.

Course Outcomes (COs):

1. Understand the principles and components of Decision Support Systems.
2. Analyze the design aspects and issues of distributed operating systems.
3. Apply various intelligent techniques to solve decision-making problems.
4. Design and develop effective Decision Support Systems.
5. Analyze and evaluate the performance of Intelligent Systems in practical applications.

CO-PO/PSO Mapping: (sample set/need modification)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	2	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	1
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	3	1
CO5	3	3	3	3	-	-	-	-	3	2	-	-	3	2	1
CO	3	3	3	3	-	-	-	-	3	2	-	3	3	3	3

Course Content:

Module 1: Introduction to Decision Support Systems (DSS) [8L]
Overview of Decision Support Systems, Components of DSS, Types of DSS, Decision-Making Models, Data Warehousing for DSS.

Module 2: Intelligent Systems and Their Types [6L]
Introduction to Intelligent Systems, Expert Systems, Neural Networks in Decision Support, Fuzzy Logic and Decision Support, Genetic Algorithms for Optimization

Module 3: Building Decision Support Systems [4L]
Designing DSS Interfaces, Data Visualization for Decision Support, DSS Development Life Cycle, Case Studies in DSS Implementation.

Module 4: Machine Learning for Intelligent Decision-Making [8L]
Supervised and Unsupervised Learning, Classification and Clustering Algorithms, Decision Trees for Decision Support, Practical Applications of Machine Learning in DSS.

Module 5: Advanced Topics in Intelligent Systems [10L]
Natural Language Processing for DSS, Recommender Systems, Swarm Intelligence and Its Applications, Ethical Considerations in Intelligent Decision-Making.

Recommended Text Books

1. Decision Support Systems and Intelligent Systems" by Efraim Turban, Jay E. Aronson, and Ting-Peng Liang, Pearson.

Recommended Reference Books

1. "Business Intelligence: A Managerial Approach" by Efraim Turban, Ramesh Sharda, Dursun Delen, Pearson.
2. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, Pearson.

Course Name: Parallel and Distributed Computing
Paper Code: DS702C
Contact (L: T: P): 3 0 0
Total Contact Hours: 36
Credit: 3

Prerequisites: Knowledge of Data Structures, Algorithms, and Computer Architecture will be helpful.

Course Objectives: The objective of the course is to make the students able to -

1. Understand the fundamentals of parallel and distributed computing.
2. Learn various parallel programming models and paradigms.
3. Explore the design and implementation of distributed systems.
4. Achieve practical experience in developing parallel and distributed applications.

Course Outcomes (Cos):

1. Understand the principles of parallel computing and its relevance in modern computing systems.
2. Design and implement parallel algorithms using different models.
3. Comprehend the challenges and solutions in distributed computing.
4. Develop distributed applications and evaluate their performance.
5. Implement and optimize parallel and distributed algorithms for solving complex computational problems.

CO-PO/PSO Mapping: (sample set)

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	2	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	1
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	3	1
CO5	3	3	3	3	-	-	-	-	3	2	-	-	3	2	1
CO	3	3	3	3	-	-	-	-	3	2	-	3	3	3	3

Course Content:

Module 1: Introduction to Parallel Computing [8L]
Basics of Parallel Computing, Parallel Architectures and Models, Parallel Programming Paradigms, Parallel Algorithms and Complexity Analysis.

Module 2: Parallel Programming Models [6L]
Shared Memory and Message Passing Models, Multithreading and Parallelism in Programming Languages, Parallelism in GPUs and Accelerators Case Studies in Parallel Programming.

Module 3: Distributed Systems Fundamentals [4L]
Introduction to Distributed Systems, Characteristics and Challenges in Distributed Computing, Distributed Algorithms and Synchronization, Distributed Operating Systems.

Module 4: Distributed Systems Design and Implementation [8L]
Distributed File Systems and Storage, Distributed Databases and Data Replication, Middleware for Distributed Systems, Case Studies in Building Distributed Applications.

Module 5: Performance Evaluation and Future Trends [10L]
Performance Metrics in Parallel and Distributed Computing, Load Balancing and Scalability, Cloud Computing and Edge Computing, Emerging Trends in Parallel and Distributed Systems.

Recommended Text Books

1. Parallel and Distributed Computing: Architectures and Algorithms, by Basu S. K.

Recommended Reference Books

1. Distributed Systems: Principles and Paradigms" by Andrew S. Tanenbaum and Maarten Van Steen, Pearson. Topics, McGraw-Hill.
2. Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, by Wilkinson.

Course Name: Information Theory and Coding
Course Code: DS703A
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites: Probability & Statistics

Course Outcomes (COs):
After attending the course students should be able to

CO1	Illustrate the basic concept of information and apply this knowledge to design solution for real lifeengineering problem.
CO2	Illustrate the basic concept of coding theory and use this knowledge to design and solve mathematical and engineering problem leading to lifelong learning.
CO3	Interpret the concept of channel models to find amount of mutual information in the channels.
CO4	Compare the existing error detection techniques and design a model for building a new solution as a professional engineering practice as a team.
CO5	Understand how convolutional theory works and develop an approach by means of existing and new methods as a team work.

Course Content:
Module 1:
Information Theory [4L]
Introduction, Measure of Information, Average Information Content (Entropy) of a Zero Memory Source,Extension of Zero Memory Source, Entropy of a Source with Memory.

Module 2:
Source Coding [9L]
Introduction, Types of Codes, Prefix Codes, Source Coding Theorem, Shannon‘s Encoding Theorem, Huffman Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Run Length Encoding, An Overview on Speech and Image Compression.

Module 3:
Information Channels[4L]
Introduction, Channel Models, System Entropies, Mutual Information (Trans information), Channel Capacity, Capacity of Channels, Continuous Channels.

Module 4:
Error Control Coding [8L]
Introduction, need for Error Control Coding, Types of Codes, Coding Gain, Linear Block Codes, The Hamming Codes, Probability of an Undetected Error Pattern for an LBC over a BSC, Equivalent Codes, Cyclic Codes, Golay Codes, Shortened Cyclic Codes.

Module 5:
Burst Error Correcting Codes [6L]
Introduction, Burst Errors, Interleaved Codes, Product Codes, Fire Codes, BCH Codes, Non-Binary BCH Codes and Reed-Solomon Codes.

Module 6:

Convolution Codes[5L]

Introduction, Convolution Encoder, Representation of Convolution Code, Transfer Function of a Convolution Code, Distance Properties of Convolution Codes, Decoding of Convolution Codes, Stack Algorithm, Known Good Convolution Codes.

Textbook:

Information theory, coding and cryptography - Ranjan Bose; TMH.
Information and Coding - N Abramson; McGraw Hill.

ReferenceBooks:

Introduction to Information Theory - M Mansurpur; McGraw Hill.
Information Theory - R B Ash; Prentice Hall.
Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-								
CO2	3	3	3	3								
CO3	3	3	3	3								
CO4	3	3	3	3								
CO5	3	3	3	3								

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	2	3
CO3	3	3	2
CO4	3	2	3
CO5	3	2	3

Name of the Paper: Sensor Networks and IoT
Paper Code: DS703B
Contact (Periods/Week):=3L/Week
Credit Point: 3
No. of Lectures: 36

Prerequisite:

1. Fundamental knowledge in computer networking.
2. Basic knowledge of Microcontroller fundamentals.

Course Objective(s)
Students will understand the concepts of Internet of Things and can able to build IoT applications.

Course Outcome(s)
On completion of the course students will be able:

CO1	**Understand and differentiate** the concepts of Internet of Things and Internet
CO2	**Identify** appropriate MAC protocols and routing protocols while solving a problem
CO3	**Analyze and compare** the basic protocols in wireless sensor network and IoT
CO4	**Solve** different real life problems in different domains based upon the concept of IoT and sensor network
CO5	**Implement** basic IoT applications on embedded platform

Syllabus

Module I: [7L]
Fundamental of IoT
The Internet of Things, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Design challenges, Development challenges, Security challenges, Other challenges.

Module II: [6L]
Wireless Sensor Network
Network & Communication aspects, Wireless medium access issues, MAC protocol , routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.

Module III: [7L]
IoT and M2M
A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module IV: [7L]
IoT Architecture
Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module V: [5L]
IoT Applications for Value Creations
Introduction to Arduino and Raspberry Pi, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT in health care, Value for Industry, smart home Management.

Module VI: [4L]
Internet of Things Privacy, Security and Governance
Introduction, Overview of Governance, Privacy and Security Issues, Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in smart cities, Security.

Text books:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.

Reference books:

1. Cuno Pfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493-9357-1
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

Mapping of Course Outcomes with Pos (&PSOs)

CO #	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	2	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	2	-	1	-	-	-	-	-	3	3	3
CO4	3	3	3	3	3	2	2	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	2	2	-	2	2	1	1	3	2	2
CO1	3	3	3	3	3	2	2	-	2	2	1	1	3	3	3

Course Name: Data Mining and Data Warehousing
Course Code: DS703C
Contact: 3:0:0
Total Contact Hours: 36Credits: 3

Prerequisites: Data Structure, Design and Analysis of Algorithms, Database Management Systems, Statistics,Artificial Intelligence

Course Outcomes (COs):
After attending the course students should be able to the relevant problems.

CO1	Understand and explain the fundamental concepts of the evolving technologies in Data Mining (such as Mining Frequent Patterns and Data Streams, Associations, Supervised and Unsupervised Learning Graph Mining, Web Mining etc.) and Data Warehousing (such as Data Cube and OLAP)recognizingtheir utilitarian importance in current technological context for further exploration leading towardslifelong learning.
CO2	Identify and formulate an engineering problem within the scope of Data Mining and Data Warehousing paradigm.
CO3	Explore relevant literature and apply the concepts of Data Mining and Data Warehousing to solve problems of making automated decisions dealing with large scale data.
CO4	Develop ideas for proposing solutions to the challenging problems of Data Mining and Data Warehousing.
CO5	Implement ideas of Data Mining and Data Warehousing through developing feasible algorithms or frameworks and investigate their effectiveness in solving the relevant problems by analyzing the performances using proper techniques.

Course Content:
Module-1: Introduction to Data Mining[5L]
Basic Concepts 1L
Data Exploration: Data Types, Data Attributes, Statistical Description of Data, Data Visualization, Data SimilarityMeasure 2L
Data Preprocessing: Data Cleaning, Data Integration, Data Reduction, Data Transformation & Discretization 2L

Module-2: Introduction to Data Warehousing [6L]
Basic Concepts 1L
Data Warehouse Modeling: Data Cubeand OLAP (OnLine Analytical Processing) 2LData Warehouse Design, Usage, Implementation 2L
Data Generalization by Attribute-OrientedInduction 1L
Module-3:Mining Frequent Patterns,Associations And Correlation Analysis [5L]
Basic Concepts, Frequent Itemset Mining Methods: The Apriori Algorithm, Mining Frequent Item Sets withoutCandidate Generation, Mining Frequent ItemSets Using Vertical Data Format, Correlation Analysis 4L
Pattern Mining in Multilevel and Multidimensional Space 1L

Module-4: Classification and Regression [6L]
Basic Concepts, k-Nearest-Neighbor Classifier, Decision Tree Classifier, Naïve Bayes Classifier 3L
ANN-Backpropagation Based Classifier, Support Vector Machine Based Classifier, Linear and Nonlinear Regression Methods 3L

Module-5: Clustering and Outlier Analysis [5L]
Basic Concepts, Partitioning Methods: k-Means and k-Medoids, Hierarchical Methods: Agglomerative and

Divisive Hierarchical Clustering, Density-Based Methods: DBSCAN: Density-Based Clustering Based on ConnectedRegions with High Density, Frequent Pattern–Based Clustering Method 4L
Outlier Analysis 1L

Module-6: Mining Data Stream, Time-Series, and Sequence Data [3L]
Basic Concepts of Data Stream Mining 1L
Mining Time Series Data 1L
Mining Sequence Patterns in Biological Data 1L

Module-7: Introduction to Graph Mining, Social Network Analysis,Multi-relational Data Mining, Text Mining and World Wide Web (WWW) Mining 6L
Graph Mining: Methods for Mining Frequent Subgraphs (Apriori-based Approach& Pattern Growth Approach)2L
Basic Concepts of Social Network Analysis and Multi-relational Data Mining2L
Basic Concepts of Text Mining 1L
Basic Concepts of World Wide Web (WWW) Mining 1L

Textbook:
1.Han J & Kamber M, ‐Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, Third Edition. 2.Parteek Bhatia, ‐Data Mining and Data Warehousing: Principles and Practical Techniques‖, Cambridge University Press.

ReferenceBooks:
1.Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, ‐Introduction to Data Mining‖, PearsonEducation. 2.Robert Layton, ‐Learning Data Miningwith Python‖, Packt Publishing

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2								3
CO2	3	2	2	2								
CO3	3	3	2	2								
CO4	3	2	2	2								
CO5	3	2	2	2								

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Time Series Analysis and Forecasting
Paper Code: CS(DS)701A
Contact (L: T: P): 3: 0: 0
Total Contact Hours: 36
Credit: 3

Prerequisites: Knowledge in Python, Statistics and Probability, Machine Learning

Course Objectives:

1. Students will learn about important time series models and their applications in various fields and formulate the real life problems using time series model.
2. Students will be able to use statistical software to estimate the models from real data, and draw conclusions and develop solutions from the estimated models.
3. Students will learn to use visual and numerical diagnostics to assess the soundness of their models.
4. Students will learn to communicate the statistical analyses of substantial data sets through explanatory text, tables and graphs.
5. Students will learn to combine and adapt different statistical models to analyze larger and more complex data

Course Outcomes (COs):
CO1: **Forecast** the trend pattern exhibited by the given data by using various methods
CO2: **Run** and **interpret** time series models and regression models for time series
CO3: **Use** the Box-Jenkins approach to model and forecast time series data empirically.
CO4: **Analyze** and **estimate** the cyclic components using special processes.

CO-PO/PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	3	-	-	-	-	-	3	3	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	3	3	3	3	3
CO3	2	3	3	3	3	-	-	-	-	-	3	3	3	3	3
CO4	2	3	3	3	3	-	-	-	-	-	3	3	3	3	3

Course Content:
Module – 1: Introduction (3L): Examples of time-series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components, **Stochastic process and its main characteristics (4L):** Stochastic process, Time series as a discrete stochastic process, Main characteristics of stochastic processes (means, auto-covariation and autocorrelation functions), Stationary stochastic processes, The main characteristic of stochastic component of time series, Wold decomposition, Lag operator.

Module – 2: Stationary Process and Autoregressive-moving average (ARMA) Models (10 L): Basic properties and linear processes, Introduction to ARMA models, properties of sample mean and autocorrelation function, ARMA(p, q) processes, ACF and PACF, Forecasting of ARMA processes, Box-Jenkins' approach Coefficients estimation in autoregressive models, Quality of adjustment of time series models, AIC information criterion, BIC information criterion, "Portmonto"-statistics, Box-Jenkins methodology to identification of stationary time series models, Forecasting in the framework of Box-Jenkins model Forecasting.

Module – 3: Non-stationary time series (4L): Non-stationary time series, Time series with non-

stationary variance, Non-stationary mean, ARIMA (p,d,q) models, The use of Box-Jenkins methodology to determination of order of integration, **The unit root problem (4L):** The unit root problem. Spurious trends and regressions, Unit root tests (Dickey-Fuller), ADF test and the choice of the number of lags, Other unit root tests, **Unit root and structure changes (3L):** Non-stationary time series, TSP or DSP: methodology of research, Segmented trends and structure changes.

Module – 4: Regressive dynamic models (3L): Regressive dynamic models, Autoregressive models with distributed lags (ADL), **Vector auto regression model and co-integration (2L):** Time series co-integration**,** Co-integration regression, Testing of co-integration, **Vector autoregression and co-integration (2L):** Co-integration and error correction model, **Causality in time series Granger causality(2L):** Hypothesis testing on rational expectations. Hypothesis testing on market efficiency.

Recommended Text Books

7. Introduction to Time Series and Forecasting, Brockwell, Peter J. and Davis, Richard A. Springer Verlag, New York (2002).
8. Time Series Models, Andrew C. Harvey, Harvester Wheatsheaf, 1993.

Note: Try to restrict within 2 textbooks. Follow the format below.

Recommended Reference Books

4. Econometric Methods, J. Johnston, J. DiNardo, McGraw-Hill, 1997.
5. Time Series Analysis: Forecasting and Control, Box, G.E.P., Jenkins, G.M. and Reinsel, G.C., Prentice Hall, New Jersey, 1994.
6. The Analysis of Time Series, Chatfield, C., 5th edition, Chapman and Hall, New York, 1996.

Note: You can add as many as reference books you want following the format below.

Course Name: Image Processing
Course Code: CS(DS)701B
Contact: 3:0:0
Total Contact Hours: 36Credits: 3

Prerequisite: Fourier analysis**,** Linear algebra**,** Probability

Course Outcomes (COs):
After attending the course students should be able to

CO1	Understand the basic concepts of digital image processing to Explain or Illustrate and Identify problemswhere students can Apply the concept appropriately to Solve them.
CO2	Understand the fundamental concepts of image enhancement strategies and Identify the scope ofenhancement where students can Apply the appropriate strategy and Analyze the performance.
CO3	Illustrate the fundamental image restoration strategies and Apply them appropriately to eliminate noisein the image.
CO4	Illustrate various Image Compression Techniques and Apply them to compress the images and Analyzetheir performances.
CO5	Understand and Develop ideas to Propose solutions to the problems of Morphological Image Processingand Image Segmentation and Analyze the effectiveness as well as limitations of solutions underscoring its utilitarian importance for further explorations leading towards lifelong learning.

Course Contents:
Module -1: Introduction:[5L]
Digital Image Fundamentals : Overview, Computer imaging systems , Digital Image Representation, Fundamental steps in Image Processing [1L], Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display [1L]. Digital Image Formation: A Simple Image Model, Use and Analysis of Color Models in Image Processing [2L], Sampling & Quantization
- Uniform & Non-uniform [1L].

Module -2: Mathematical Preliminaries : [5L]
Neighbour of pixels, Connectivity, Relations, Equivalence & Transitive Closure [1L]; Distance Measures, Arithmetic/Logic Operations, Discrete Signals and Systems [1L]- A Review – Fourier Transformation, Properties of The Two Dimensional Fourier Transform [2L], Discrete Fourier Transform, Discrete Cosine & Sine Transform [1L].

Module 3: Image Enhancement : [6L]
Spatial Domain: Gray level transformations – Histogram processing [2L] Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering – Frequency Domain [2L]– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters [2L].

Module -4: Image Restoration, Segmentation and Filtering :[14L]
Image Restoration and Segmentation:Image restoration: noise removal: mean & adaptive filters, degradation model, inverse filter [2L]. Discrete Formulation, Algebraic Approach to RestorationUnconstrained & Constrained [1L]; Constrained Least Square Restoration, Restoration by

Homomorphic Filtering [1L], Geometric Transformation - Spatial Transformation, Gray Level Interpolation [1L]. Image Segmentation : Point Detection, Line Detection, Edge detection, Combineddetection [2L],

Module -5: Edge Linking, Boundary Detection and Image compression : [5L]
Edge Linking & Boundary Detection- Local Processing, Global Processing via The Hough Transform [2L]; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding[2L]; Region Oriented Segmentation - Basic Formulation, Region Growing by PixelAggregation, Region Splitting &Merging [2L], Image compression: system model, lossless methods, lossy methods [2L]

Module -6: Image Representation and Recognition :[5L]
Image Representation and Recognition :Boundary representation – Chain Code – Polygonal approximation [1L], signature, boundary segments – Boundary description [1L] – Shape number- Fourier Descriptor [1L], moments- Regional Descriptors –Topological feature [1L], Texture – Patterns and Pattern classes – Recognition based on matching [1L].

Text Books:
1. Chanda & Majumder , Digital Image Processing & Analysis, PHI

Reference books:
Malay K. Pakhira, Digital Image Processing and Pattern Recognition, First Edition,PHI Learning Pvt. Ltd.,2011.
Rafael C. Gonzales and Richard E. Woods, Digital Image Processing, Third Edition,PearsonEducation,2010.

CO-PO Mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2								
CO2	3	3	2	3								
CO3	3	3	2	2								
CO4	3	2	3	2								
CO5	3	2	2	2								

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Course Name: Neural Network and Deep Learning Lab
Paper Code:DS791
Contact (L: T: P): 0:0:3
Total Contact Hours: 36
Credit: 1.5

Prerequisites:

Basic knowledge of Python and MATLAB.

Course Objectives:

To understand the basics in deep neural networks

• To understand the basics of associative memory and unsupervised learning networks

• To apply CNN architectures of deep neural networks

• To analyze the key computations underlying deep learning, then use them to build and train deep neural networks for various tasks.

Course Outcomes (COs):

On successful completion of the course, the students will be able to:

CO1	Apply Convolution Neural Network for image processing.
CO2	Understand the basics of associative memory and unsupervised learning networks.
CO3	Apply CNN and its variants for suitable applications.
CO4	Analyze the key computations underlying deep learning and use them to build and train deep neural networks for various tasks.
CO5	Apply different deep learning models for suitable applications.

CO-PO/PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2									3	3	3
CO2	2	3	2	2									3	3	3
CO3	2	3	3	2									3	3	3
CO4	2	3	3	2									3	3	3
CO5	2	3	3	2									3	3	3

Course Content:

1. Implementation of different activation functions to train Neural Network.

2. Implementation of different Learning Rules.

3. Implementation of Perceptron Networks.

4. Implementation of Adeline network for system identification.

5. Implementation of Madeline network

6. Pattern matching using different rules.

7. Project related to application of machine learning in healthcare**.**

8. Project related to application of machine learning in business analysis.

9. Project related to application of machine learning in sports analytics

10. Project related to application of machine learning in Time Series Analysis & Forecasting.

Recommended Text Books

1. S. N.Sivanandam and S. N.Deepa, Introduction to neural networks using Matlab, 2016.
2. Simon Haykin, Neural Networks and Learning Machines, PHI, 2008.

Course Name: Advanced Algorithms Lab
Course Code: DS792A
Contact: 0:0:3
Credits: 1.5

Prerequisites:
Programming knowledge
Knowledge of Design and Analysis of Algorithm

Course Outcomes (COs):
After attending the course students should be able to

CO1	Illustrate and use proper syntax in appropriate platform for developing program to solve problems related to Mathematics and Engineering field leading to lifelong learning.
CO2	Apply the knowledge of algorithms in the computational area to efficient programming codes to design the problem using modern tools for solving complex engineering problems.
CO3	Outline different types of digital electronic circuits such as adder, subtract or, encoder decoder, multiplexer, de-multiplexer, flip-flops, register, counter using various mapping and modern tools to prepare the most simplified circuit and optimize using various mapping and mathematical methods for solving the problem as a professional engineering practice as a team.
CO4	Apply the knowledge of digital electronic circuits to design memory and ALU and analyse the same to solve engineering-related computational problems as a team.
CO5	Interpret the result of the experiments, prepare laboratory reports based on observed output and analyse it to validate professional ethics and responsibilities and norms of the engineering practice.

Course Content:

Write the following problems in any programming language. Programming Language used: C

1. Divide and Conquer: Implementation of finding Maximum and Minimum element from an array of integer, Quick Sort, Check the running time for different positions of pivot elements. Randomized version of quick sort using Divide and Conquer Method.
2. Dynamic Programming: Calculation of the minimum number of scalar multiplication needed for chain of Matrices Multiplication Technique, Implementation of Single Source shortest Path for a graph (Dijkstra and Bellman Ford Algorithm), Implement all pair Shortest path for a graph (FloydWarshall Algorithm)

3. Greedy method: Implementation of fractional Knapsack Problem, MST by Prim‘s algorithm, ImplementMST by Kruskal‘s algorithm
4. Graph Traversal Algorithm: Implement Depth First Search (DFS), application of DFS (do topologicalsorting, identify strongly connected components)
5. String Matching: Implement KMP algorithm
6. Network Flow: Implement Ford-Fulkerson algorithm to get maximum flow of a given flow network.
7. Modulo Representation of integers/ polynomials: Chinese Remainder Theorem
8. Linear Programming: Simplex Algorithm

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEC-CS-T-591.1	3	3	3	2	3				3			
PEC-CS-T-591.2	3	3	3	3	3				3			
PEC-CS-T-591.3	3	3	3	3	3				3			
PEC-CS-T-591.4	3	3	3	3	3				3			
PEC-CS-T-591.5	3	3	3	3	3				3			

CO-PSO Mapping

COs	PSO1	PSO2	PSO3
PEC-CS-T-591.1	3	3	3
PEC-CS-T-591.2	3	3	3
PEC-CS-T-591.3	3	3	3
PEC-CS-T-591.4	3	3	3
PEC-CS-T-591.5	3	3	3

Course Name: Decision Support Systems and Intelligent Systems Lab
Paper Code: DS792B
Contact (L: T: P): 0 0 3
Total Contact Hours: 36
Credit: 1.5

Prerequisites: Completion of the Decision Support Systems and Intelligent Systems (DS702B) course.

Course Objectives: The objective of the course is to make the students able to -

1. The primary objective of this lab course is to offer students practical, hands-on experience in the development of Decision Support Systems (DSS) and Intelligent Systems (IS) applications.
2. This practical application will reinforce their understanding of DSS and IS principles and how they are used in solving complex problems.
3. Students will be encouraged to think critically and evaluate the effectiveness of the DSS and IS applications they develop.

Course Outcomes (Cos):

1. Implement parallel algorithms using different parallel programming models.
2. Develop distributed applications and understand the challenges in distributed computing.
3. Optimize parallel and distributed applications for enhanced performance.
4. Collaborate effectively in teams to tackle complex computing problems in parallel and distributed environments.

CO-PO/PSO Mapping: (sample)

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	2	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	1
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	3	1
CO5	3	3	3	3	-	-	-	-	3	2	-	-	3	2	1
CO	3	3	3	3	-	-	-	-	3	2	-	3	3	3	3

Course Content:

Lab Module 1: Decision Support System Development [8L]
Identify a practical business problem for DSS development. Design the user interface for the DSS. Implement the DSS using appropriate software tools. Test and debug the DSS. Evaluate the DSS's effectiveness in solving the identified problem.

Lab Module 2: Intelligent Systems Development [6L]
Select an application domain for an intelligent system (e.g., expert system). Design the knowledge representation and rule-based system. Implement the intelligent system using relevant software. Test and validate the intelligent system's performance. Analyze the results and fine-tune the system if necessary.

Lab Module 3: Experimentation and Evaluation [4L]
Conduct experiments using various decision support and intelligent system tools. Collect and analyze data from experiments. Evaluate the performance and accuracy of implemented systems. Draw conclusions and make recommendations based on experimental results.

Lab Module 4: Group Projects [18L]

Work in teams to tackle complex decision support or intelligent systems projects. Apply the knowledge and skills acquired in previous modules to address real-world problems. Present project findings and outcomes to the class.

Recommended Text Books

1. Decision Support Systems and Intelligent Systems" by Efraim Turban, Jay E. Aronson, and Ting-Peng Liang, Pearson.

Recommended Reference Books

3. "Business Intelligence: A Managerial Approach" by Efraim Turban, Ramesh Sharda, Dursun Delen, Pearson.
4. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, Pearson.

Course Name: Parallel and Distributed Computing Lab
Paper Code: DS792C
Contact (L: T: P): 0 0 3
Total Contact Hours: 36
Credit: 1.5

Prerequisites: Completion of the "Parallel and Distributed Computing (DS702C)" course.

Course Objectives: The objective of the course is to make the students able to -

1. The primary objective of this course is to offer students practical, hands-on experience in the development and optimization of parallel and distributed computing applications.
2. Students will gain a deep understanding of various parallel programming paradigms, including multi-threading, SIMD, and MIMD. They will learn how to harness the power of parallelism to improve the performance of applications and solve computationally intensive problems efficiently.
3. The course will reinforce students' knowledge of fundamental distributed computing concepts such as distributed data storage, message passing, and fault tolerance.
4. Students will work on projects that require them to apply their knowledge and skills to solve complex, computationally intensive problems encountered in various domains.
5. Students will learn how to measure and evaluate the performance of parallel and distributed computing applications. This includes profiling and benchmarking techniques to identify bottlenecks and areas for improvement.

Course Outcomes (Cos):

1. Implement parallel algorithms using different parallel programming models.
2. Develop distributed applications and understand the challenges in distributed computing.
3. Optimize parallel and distributed applications for enhanced performance.
4. Apply the knowledge of digital electronic circuits to design memory and ALU and analyse the same to solve engineering-related computational problems as a team.
5. Collaborate effectively in teams to tackle complex computing problems in parallel and distributed environments.

CO-PO/PSO Mapping: (sample)

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	2	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	1
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	3	1
CO5	3	3	3	3	-	-	-	-	3	2	-	-	3	2	1
CO	3	3	3	3	-	-	-	-	3	2	-	3	3	3	3

Course Content:

Lab Module 1: Parallel Programming Models [9L]
Implementing parallel algorithms using the shared memory model, developing parallel applications with message-passing (MPI) model, utilizing multithreading for parallelism, Experimenting with GPU acceleration.

Lab Module 2: Distributed Systems Development [9L]
Designing and implementing distributed applications, working with distributed file systems, developing distributed databases and data replication strategies, handling synchronization and communication in distributed systems.

Lab Module 3: Performance Optimization [9L]
Identifying performance bottlenecks in parallel and distributed applications, load balancing and scalability in distributed computing, profiling and benchmarking parallel code, implementing optimizations for enhanced performance.

Lab Module 4: Cloud and Edge Computing [9L]
Understanding cloud computing and its services, developing applications for the cloud environment, exploring edge computing and its significance, implementing edge computing solutions.

Recommended Text Books

1. Parallel and Distributed Computing: Architectures and Algorithms, by Basu S. K.

Recommended Reference Books

5. Distributed Systems: Principles and Paradigms" by Andrew S. Tanenbaum and Maarten Van Steen, Pearson. Topics, McGraw-Hill.
6. Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, by Wilkinson.

Course Name: Information Theory and Coding Lab
Course Code: PEC-CS-T-791
Contact: 0:0:3
Credits: 1.5

Prerequisites: Knowledge of C programming and MATLAB

Course Outcome(s):
After completion of the course students will be able to
CO1 Understand and use proper code in appropriate platform using suitable syntax for developing program tosolve problems related to Mathematics and Engineering field leading to lifelong learning.
CO2 Identify and use variables, constants, data type, operator, expression, statements, loops, vector, matrix, array, function, file handling to design the problem using modern tools for solving complex engineering problems.
CO3 Apply a top-down, modular, and systematic approach to construct the programs to solve the problem asa professional engineering practice.
CO4 Apply a variety of common numeric techniques to solve and analyse engineering-related computationalproblems.
CO5 Interpret the result of the experiments, prepare laboratory reports based on observed output and analyseit to validate professional ethics and responsibilities and norms of the engineering practice.

Course Content:
Module-1:
Revision on programming using C language. Familiarization with MATLAB environment setup, syntax, variables, commands, data types, operators, decisions, loops, vectors, matrix, arrays, functions, and advanced part, creating and editing basic MATLAB program in an editor, compilation and execution of MATLABprogram.
Module-2:
Determination of various entropies and mutual information using C/MATLAB of the following channelsNoise free channel, Noisy channel

Module-3:
Generation and evaluation of following variable source coding using C/MATLAB Shannon – Fano coding, Huffman Coding and Decoding Lempel Ziv Coding and Decoding

Module-4:
Coding &Decoding of the following codes using C/MATLABLinear block codes, Cyclic codes Convolutional codes

Module-5:
Coding &Decoding of the following codes using C/MATLABBCH code, RS code

Module-6:
Problem based on Coded and uncoded communication system (Calculate the error probability) using C/MATLAB.Source coding and channel coding for transmitting a text file using C/MATLAB.

Text book:
Information theory, coding and cryptography - Ranjan Bose; TMH.
Process Control – A First Course with MATLAB - Pao C. Chau; Cambridge University Press

Reference Books:

Introduction to Information Theory - M Mansurpur; McGraw Hill.
Information Theory - R B Ash; Prentice Hall.
Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall.
Information and Coding - N Abramson; McGraw Hill.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	-	-	-	-	3
CO2	3	3	3	3	3	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	3	-	-	-	-
CO4	3	3	3	3	-	-	-	3	3	-	-	-
CO5	-	-	-	-	-	-	-	3	-	3	-	-

Course Name: Data Mining and Data Warehousing Lab
Course Code: DS793C
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisites:
Data Structure& Programming, Design and Analysis of Algorithms, Database Management Systems, Statistics,Artificial Intelligence, Python Programming

Course Outcomes:
After completion of the course students will be able to
CO1: Understand and use the fundamental concepts of the evolving technologies in Data Mining and Data Warehousing through implementing them using proper techniques and tools to recognize their utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2: Identify and formulate an engineering problem by exploring contextual data and its characteristics within the scope of Data Mining and Data Warehousing paradigm.
CO3: Explore relevant literature and apply the concepts of Data Mining and Data Warehousing by implementing well-known algorithmic solutions using proper techniques and tools to solve contextual problems.
CO4: Develop ideas and propose technical solutions to the challenging problems of Data Mining and DataWarehousing.
CO5: Plan and Implement Data Mining based ideas as executable programs(preferably termed as models)by developing suitable algorithms with adequate documentation in collaborative environment for successfully carrying out projects on Data Mining and Data Warehousing and investigate their effectiveness by analyzing the performances using proper techniques and tools.

Course Content:
WEEK-1:
Introduction to Data Mining Programming Platform 3L
Introduction to Data Mining Programming Platform and Data Exploration: Data Types, Data Attributes, Statistical Description of Data, Data Visualization, Data Feature Vectors, Data Preprocessing: Data Cleaning, Data Transformation 3L

WEEK -2:
Affinity Analysis 3L
Implementation and Analysis of Recommending Engine 3L

WEEK -3:Association Analysis 3L Implementationand Analysis of Apriori Algorithm 3L

WEEK -4:Regression 3L
Implementation and Analysis of Linear and Nonlinear Regression Methods 3L

WEEK -5:Classification 3L
Implementation and Analysis of k-Nearest-Neighbor Classifier, Decision Tree Classifier, Naïve Bayes Classifier 3L

WEEK -6:Classification 3L
Implementation and Analysis of ANN-Backpropagation and SVM Based Classifier

WEEK-7: Clustering 3L
Implementation and Analysis of k-Means and k-Medoids3L

WEEK -8:Mining Time-Series Data 3L
Implementation and Analysis of Time-Series Data Mining Models 3L

WEEK -9:
DiscussiononProject Problems and Allocation (Problem Description Report Submission) 3L

WEEK -10:DesigningSolution Model and Proposal Report Submission 3L WEEK -11:ProjectImplementation, Verification and Documentation 3L WEEK -12:Project Demonstration and Project Report Review 3L

Textbook:

Han J &Kamber M, ‒Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, Third Edition.
Parteek Bhatia, ‒Data Mining and Data Warehousing: Principles and Practical Techniques‖, Cambridge University Press.

Reference Books:

Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, ‒Introduction to Data Mining‖, PearsonEducation.
Robert Layton, ‒Learning Data Miningwith Python‖, Packt Publishing

CO–PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	3
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	2
CO5	2	2	3	3	2	2	2	2	2	2	2	2

Course Name: Time Series Analysis and Forecasting Lab
Course Code: CS(DS)791A
Contact (L: T: P): 3 : 0 : 0
Total Contact Hours: 36
Credit: 3
Prerequisites: Knowledge in Python, Statistics and Probability, Machine Learning
Course Objectives:

1. Students will learn about important time series models and their applications in various fields and formulate the real life problems using time series model.
2. Students will be able to use statistical software to estimate the models from real data, and draw conclusions and develop solutions from the estimated models.
3. Students will learn to use visual and numerical diagnostics to assess the soundness of their models.
4. Students will learn to communicate the statistical analyses of substantial data sets through explanatory text, tables and graphs.
5. Students will learn to combine and adapt different statistical models to analyze larger and more complex data

Course Outcomes (COs):
CO1: **Forecast** the trend pattern exhibited by the given data by using various methods
CO2: **Run** and **interpret** time series models and regression models for time series
CO3: **Use** the Box-Jenkins approach to model and forecast time series data empirically.
CO4: **Analyze** and **estimate** the cyclic components using special processes.

CO-PO/PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	3	-	-	-	2	-	3	3	3	3	3
CO2	3	3	3	3	3	-	-	-	2	-	3	3	3	3	3
CO3	2	3	3	3	3	-	-	-	2	-	3	3	3	3	3
CO4	2	3	3	3	3	-	-	-	2	-	3	3	3	3	3

Course Content:

1. Time Series Data Cleaning, Loading and Handling Times series data, Preprocessing Techniques
2. Checking of Stationarity of a Time Series, To make a Time Series Stationary, Estimating & Eliminating Trend, Aggregation, Smoothing, Polynomial Fitting Eliminating Trend and Seasonality, Differencing, Decomposition
3. Moving Average time analysis data, Smoothing the Time analysis Data, Checking out the Time series Linear and non-linear trends, Create a modelling.
4. Modelling time series, Moving average, Exponential smoothing, ARIMA Seasonal autoregressive integrated moving average model (SARIMA)
5. Dependence Techniques, Multivariate Analysis of Variance and Covariance, Canonical Correlation Analysis, Structural Equation Modelling Inter-Dependence Techniques Factor Analysis Cluster Analysis.

Course Name: Image Processing Lab
Course Code: OEC-CS-791B
Contact: 0:0:3
Contact Hours: 33
Credits: 1.5

Prerequisite:

Should have prior knowledge on syntaxes of programming like C++, JAVA.

Course Outcome(s):

After completion of the course students will be able to

CO1: Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement,segmentation, transforms, compression, morphology, representation and description.
CO2: Analyze images in the spatial domain.
CO3: Analyze images in the frequency domain through the Fourier transform.
CO4: Design and implement with MATLAB algorithms for digital image processing operations such as point processing,histogram processing,
CO5: Spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing.

Experiments:

1. W.A.P in MATLAB to extract different attributes of an Image.
2. W.A.P in MATLAB program for Image Negation.
3. W.A.P in MATLAB for Power Law Transformation.
4. W.A.P in MATLAB for Histogram Mapping and Equalization.
5. W.A.P in MATLAB for Image Smoothening and Sharpening.
6. W.A.P in MATLAB for Edge Detection using Sobel, Prewitt and Roberts Operators.
7. W.A.P in MATLAB for Morphological Operations on Binary Images.
8. W.A.P in MATLAB for Pseudo Colouring of images.
9. W.A.P in MATLAB for Chain Coding applied on images.
10. W.A.P in MATLAB for DCT/IDCT Computation.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	2	-	1	3	-	-	-	-	-
CO2	-	1	3	1	-	-	-	-	-	1	-	-
CO3	1	2	-	-	-	3	-	-	2	-	2	-
CO4	2	-	2	-	-	1	-	-	-	2	1	-
CO5	-	2	-	3	-	2	-	2	-	2	-	-

Course Name: Optimization Techniques Lab
Course Code: M(DS)791C
Contact: 0:0:3
Contact Hours: 33
Credits: 1.5

Course Outcome(s):

After the completion of the course, the students will be able to

1. Demonstrate the basic principles and concepts of Python
2. Explore the applicability of programming skills in Python.
3. Summarize various optimization techniques like LPP models.
4. Analyse the transportation, inventory and assignment problems.
5. Explain the concepts of sequencing, game theory and dynamic programming.

List Of Experiments (Includes but Not Limited to)

1. Matrix Operations
2. Minimum Cost Path
3. Finding Maximum Number in An Array
4. Array Sorting
5. Linear Programming Problem
6. Queuing Problem
7. Sequencing Problem
8. Game Theory
9. Assignment Problem
10. Dynamic Programming Problem
11. Inventory Problem

Recommended Books :

1. Foulds, L. R. (2012). Optimization techniques: an introduction. Springer Science & Business Media.
2. Onwubolu, G. C., & Babu, B. V. (2013). New optimization techniques in engineering (Vol. 141). Springer.
3. Lopez, C. (2014). MATLAB optimization techniques. Apress.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	2	3	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	1	3	-	3	3	-	-	-	-	-	-	-
CO5	1	3	-	2	2	-	-	-	-	-	-	-

4th Year 8th Semester									
Sl. No.	Broad Category	Category	Course Code	Course Title	Hours per week				Credits
A. THEORY					L	T	P	Total	
1	ENGG	Major	DS801A	Real-Time Systems	3	0	0	3	3
			DS801B	Data Modelling and Simulation					
			DS801C	Soft Computing					
2	HUM	Minor	HU(DS)801	Human Resource Development and Organizational Behavior	3	0	0	3	3
3	ENGG	Minor	CS(DS)801A	Nature Inspired Computing for Data Science	3	0	0	3	3
			CS(DS)801B	Bio-informatics					
			EC(DS)801C	Robotics					
B. PRACTICAL									
1	PRJ	Project	DS881	Project	0	0	16	16	8
2		Ability Enhancement Course	DS882	Grand Viva	0	0	0	0	2
		TOTAL CREDIT							19

Course Name: REAL TIME SYSTEMS
Course Code: DS801A
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:

1. Concepts of Operating systems and Algorithms.
2. Knowledge of basics of Distributed Systems.

Course Objectives:

This course is introduced to make the students able to understand the design and applications of all real-time aspects of various system components, like OS, memory, communication, and an introduction to reliability evaluation methods.

Course Outcomes: On successful completion of the course, the students will be able to:

Course Outcomes	Name of Course Outcomes
DS801A.1	Understand the concepts of Real-Time systems
DS801A.2	Recognize the characteristics of a real-time system
DS801A.3	Understand and develop documents on an architectural design of a real-time system.
DS801A.4	Develop and document Task scheduling, resource management, real-time operating systems, and fault tolerance applications of real-time systems.
DS801A.5	Apply the basics of RTOS in the interpretation of real-time systems.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS801A.1	3	2	3	1	2	-	-	-	-	-	-	-	3	2	-
DS801A.2	3	2	3	3	-	-	-	-	-	-	-	-	3	2	-
DS801A.3	3	3	3	3	2	-	-	-	-	-	-	-	2	2	2
DS801A.4	3	2	3	3	2	-	-	-	-	-	-	-	3	2	-
DS801A.5	3	3	3	3	2	-	-	-	-	-	-	-	3	2	-
	3.0	2.40	3.0	2.60	1.60	-	-	-	-	-	-	-	2.8	2.0	0.4

Course Content:

Module-1- Introduction **8L**

Definition, Typical Real-Time Applications: Digital control, High-Level Controls, Signal

processing, etc., Release Times, Deadline period and time constraints, Hard and soft real-time systems, Reference models for RTOS: Processors and Resources, Temporal parameters of Real-time workload, Periodic Task Model, Precedence Constraints and Data Dependency.

Module-2: Real-Time Scheduling **8L**

Common Approaches to Real-Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Stack-Time-First (LST) algorithms, Rate Monotonic algorithm, Offline versus Online Scheduling.

Module-3: Resources Sharing **8L**

Effect of Resource Contention and Resource Access Control (RAC), Non-pre-emptive Critical Sections, Basic Priority- Inheritance and Priority-Ceiling Protocols, stack based Priority Ceiling Protocol, Use of Priority Ceiling Protocol in Dynamic priority systems, Pre-emption Ceiling Protocol, Access control in Multiple Module Resources, Controlling Concurrent Accesses to Data Objects.

Module-4: Real-Time Communication **6L**

Basic Concepts of Real-time Communication, Soft, and Hard Real-time Communication Systems, Model of Real-time Communication, Priority based service, and Weighted Round Robin Service disciplines for switched Networks, Medium Access control protocols for broadcast networks, Internet and resource reservation protocols.

Module-5: Real-Time Operating Systems and Databases. **6L**

Features of RTOS, Time Services, UNIX as RTOS, POSIX Issues, Characteristics of temporal data, temporal consistency, on-currency Control, and Overview of Commercial Real-Time databases.

Text book:

3. Real Time Systems – Jane W. S. Liu, Pearson Education Publication

Reference Books:

1. Real Time Systems – Mall Rajiv, Pearson Education
2. Real-Time Systems: Scheduling, Analysis, and Verification – Albert M. K. Cheng, Wiley.

Course Name: DATA MODELLING AND SIMULATION
Course Code: DS801B
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:

1. Basic Mathematics: A foundational understanding of algebra, calculus, and statistics is essential for grasping the mathematical concepts underpinning data modelling and simulation.
2. Programming Skills: Proficiency in a programming language (e.g., Python, R) is necessary
3. Data Analysis Fundamentals: Familiarity with data manipulation, visualization, and basic statistical analysis will aid in interpreting and validating simulation results.

Course Objectives:
The course aims to equip students with the skills to create, analyse, and interpret data models and simulations, enabling them to make informed decisions and solve complex real-world problems.

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
DS801B.1	Model Creation: Develop the ability to construct accurate and effective data models, translating real-world scenarios into mathematical representations for simulation analysis.
DS801B.2	Simulation Proficiency: Gain expertise in designing and executing simulations, utilizing appropriate software tools to replicate and analyze complex systems.
DS801B.3	Analysis and Interpretation: Acquire skills to critically evaluate simulation results, extracting meaningful insights and making informed decisions based on the outcomes.
DS801B.4	Problem-Solving: Apply data modeling and simulation techniques to solve diverse real-world problems, addressing challenges across various domains.
DS801B.5	Effective Communication: Communicate simulation findings clearly and concisely, both orally and in written reports, to diverse audiences, emphasizing the practical implications of the results.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS801B.1	3	2	3	3	-	-	-	-	-	-	-	-	3	3	3
DS801B.2	3	3	3	2	-	-	-	-	-	-	-	-	3	3	3
DS801B.3	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
DS801B.4	2	2	3	2	-	-	-	-	-	-	-	-	3	3	3
DS801B.5	3	2	3	3	-	-	-	-	-	-	-	-	3	3	3
	2.8	**2.4**	**3.0**	**2.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3.0**	**3.0**	**3.0**

Course Content:

Module 1: Introduction to Data Modelling and Simulation
Introduction to data modeling and simulation: Concepts, significance, and applications, Types of models: Deterministic, stochastic, continuous, and discrete, Role of simulation in decision-making: Understanding its importance in various domains.

Module 2: Data Modeling and Representation
Data modeling fundamentals: Entities, attributes, relationships, and normalization, Entity-Relationship (ER) modeling: Techniques for designing effective data models, Data modeling tools: Introduction to software tools for creating and visualizing data models.

Module 3: Simulation Techniques and Methods
Introduction to simulation: Principles, advantages, and limitations, Simulation methodologies: Monte Carlo simulation, discrete-event simulation, and agent-based modeling, Verification and validation of simulation models: Ensuring accuracy and reliability.

Module 4: Simulation Implementation and Analysis
Simulation software: Introduction to popular simulation software tools, Developing simulation models: Translating real-world scenarios into simulation models, Experimentation and analysis: Designing simulation experiments and interpreting results.

Module 5: Advanced Topics in Data Modeling and Simulation
Complex systems modeling: Handling intricate systems and emergent behaviours, Optimization using simulation: Applying simulation for optimization and decision support, Simulation in various domains: Healthcare, manufacturing, logistics, and more.

Text book:

1. "Simulation Modeling and Analysis" by Averill M. Law and W. David Kelton.
2. "Data Modeling and Database Design" by Narayan S. Umanath and Richard W. Scamell

Reference Books:

7. "Discrete-Event System Simulation" by Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol
8. "Simulation with Arena" by W. David Kelton, Randall Sadowski, David T. Sturrock.

Course Name: SOFT COMPUTING
Course Code: DS801C
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:

1. Discrete Mathematics, Probability and Statistics

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
DS801C.1	Understand and explain the basic concept of soft computing and hard computing and apply them in designing solution to engineering problem.
DS801C.2	Identify and formulate learning rules for each of the architectures and learn several neural network paradigms and its applications to solving engineering and other problems.
DS801C.3	Explore relevant literature and apply fuzzy logic and reasoning to handle uncertainty and solving interdisciplinary engineering problems
DS801C.4	Use genetic algorithms to combinatorial optimization problems and recognize the feasibility of applying a soft computing methodology for a particular problem
DS801C.5	Implement the concept and techniques of designing of soft computing methods in real world problem.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DS801C.1	3	3	3	3	3	2	2	-	2	-	-	3	3	3	3
DS801C.2	3	3	3	3	3	2	2	-	2	-	-	3	3	3	3
DS801C.3	3	3	3	3	3	2	2	-	2	-	-	3	3	3	3
DS801C.4	3	3	3	3	3	2	2	-	2	-	-	3	3	3	3
DS801C.5	3	3	3	3	3	2	2	-	2	-	-	3	3	3	3
	3.0	3.0	3.0	3.0	3.0	2.0	2.0	-	2.0	-	-	3.0	3.0	3.0	3.0

Course Content:

Module-1: Introduction to Soft Computing: 8L
An Overview of Artificial Intelligence, Evolution of Computing - Soft Computing Constituents – From Conventional Artificial Intelligence to Computational Intelligence - Machine Learning Basics. Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing.

Module-2: Fuzzy sets and Fuzzy logic 7L Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle,

Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, fuzzy controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database.

Module -3: Artificial Neural Networks
9L Artificial Neural Network: Introduction, basic models, Hebb's learning, Adeline, Perception, Multilayer feed forward network. Back propagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Applications.

Module -4: Genetic Algorithms
7L Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of Genetic Algorithm, Analysis of selection operations, Hypothesis of building Blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications. Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.

Module -5: Hybrid Systems
5L

Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic controlled Genetic Algorithm. Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Text book:

1. Neural Networks, Fuzzy logic, and Genetic Algorithms‖, S. Rajasekaran & G. A. V. Pai , PHI.
2. Principles of Soft Computing‖, S.N.Sivanandam, S.N Deepa, wiley publications.
3. Neural Networks‖, S. Haykin, Pearson Education, 2ed, 2001.
4. An Introduction to Genetic Algorithm‖, Mitchell Melanie, Prentice Hall, 1998.

Reference Books:

1. Genetic Algorithms in Search, Optimization and Machine Learning‖, David E. Goldberg, Addison Wesley, 1997.
2. Intelligent Hybrid Systems‖, D. Ruan, Kluwer Academic Publisher, 1997.

Course Name: Human Resource Development and Organizational Behaviour
Course Code: HU(DS)801
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
CO1	To understand key functions in management as applied in practice.
CO2	To identify and analyse major practices associated with HRD in modern work and organisations;
CO3	To evaluate the connections between the HRD process and the contemporary performance management concerns of organisations
CO4	To analyse the behaviour of individuals and groups in organisations in terms of the key factors that influence organisational behaviour.
CO5	To assess the potential effects of organisational-level factors (such as structure, culture and change) on organisational behaviour.
CO6	To evaluate the potential effects of important developments in the external environment (such as globalisation and advances in technology) on organisational behaviour
CO7	To analyse organisational behavioural issues in the context of organisational behaviour theories, models and concepts.
CO8	To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organisational processes

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	2	3	3	3	2	3	2	2	-	-	-
CO2	2	-	-	2	-	-	2	-	3	-	3	-	-	-	-
CO3	2	-	3	2	-	3	-	-	2	-	-	-	-	-	-
CO4	-	2	-	3	2	3	-	2	-	-	-	-	-	-	-
CO5	2	-	-	-	3	2	-	-	2	-	3	-	-	-	-
CO6	2	2	-	-	-	-	-	3	3	-	2	-	-	-	-
CO7	2	2	-	-	-	-	-	-	2	-	3	3	-	-	-
CO8	2	-	3	3	-	2	-	-	2	-	-	-	-	-	-
	1.75	0.75	0.75	1.25	0.875	1.625	0.625	1.0	2.0	0.375	1.625	0.625	-	-	-

Course Content:

Module – 1 [3L]

HRD-Macro Perspective: HRD Concept, Origin and Need, HRD as a Total System; Approaches to HRD; Human Development and HRD; HRD at Macro and Micro Climate.

Module -2 [6L]
HRD–Micro Perspective: Areas of HRD; HRD Interventions Performance Appraisal, Potential Appraisal, Feedback and Performance Coaching, Training, Career Planning, OD or Systems Development, Rewards, Employee Welfare and Quality of Work Life and Human Resource Information; Staffing for HRD: Roles of HR Developer; Physical and Financial Resources for HRD; HR Accounting; HRD Audit, Strategic HRD

Module – 3 [5L]
Instructional Technology for HRD: Learning and HRD; Models and Curriculum; Principles of Learning; Group and Individual Learning; Transactional Analysis; Assessment Centre; Behaviour Modeling and Self Directed Learning; Evaluating the HRD.

Module – 4 [4L]
Human Resource Training and Development: Concept and Importance; Assessing Training Needs; Designing and Evaluating T&D Programmes; Role, Responsibilities and challenges to Training Managers.

Module – 5 [3L]

Organisational Effectiveness (OE): Concept; Approaches to O E; Adoptive Coping Cycle for Effectiveness; Achieving OE; Organisational Climate: Concept, Determinants of Organisational Climate.

Module-6 [6L]

Organization Theory: Classical Theory; Neo-Classical Theory, Modern Behavioural Theories, contingency theory, system theory, modern structural models; Organizational Culture; Creating and Sustaining Culture; Work Culture.

Module –7 [3L]

Motivation: Types of Motives; Theories of Maslow; Herzberg, McGregor, Alderfers, Porter and Lawler‘s Model; Job Enlargement, Job Enrichment, Behaviour Modification.

Module– 8 [6L]

a. Group & Group Dynamics - concept, importance, classification of groups, reason for group, formation, group cohesiveness.
b. Team work: meaning, concept, types, creating, and an effective team.
c. Leadership: Concept, Leader vs. Manager; Classical Studies on Leadership; Trait Theories; Behavioral Theories; Group and Exchange Theories; Contingency Theory of Leadership; Leadership Styles.

Text book:

1. Rao, T.V and Pareek, Udai: Designing and Managing Human Resource Systems, Oxford IBH Pub. Pvt.Ltd, New Delhi, 2005
2. Viramani, B.R and Seth, Parmila: Evaluating Management Development, Vision Books, New Delhi.
3. Rao, T.V: Human Resource Development, Sage Publications, New Delhi.
4. Luthans, Fred: Organisational Behaviour, Tata McGraw-Hill Co. New Delhi, 2004.
5. Stephen, P. Robins: Organisational Behaviour, Prentice-Hall of India Pvt., Ltd., 2004.
6. John, W. Mewstrom & Davis, Keith: Organisational Behavior (Human Behavior at Work), Tata McGraw-Hill, New Delhi, 2002

Course Name: Nature Inspired Computing for Data Science
Paper Code: CS(DS)801A
Contact (L: T: P): 3:0:0
Total Contact Hours: 36
Credit: 3
Prerequisites:

1. Programming Fundamentals on Python, Java, or C++.
2. Mathematical Proficiency in calculus, linear algebra, and probability.
3. Data Science Basics: Familiarity with key concepts in data science, machine learning, and optimization will provide a solid context for applying nature-inspired algorithms to real-world data-driven problems.

Course Objectives:
The course delves into diverse nature-inspired computing techniques, covering biological and non-biological models. It applies these methods to optimization, machine learning, and robotics, including cellular automata, neural networks, and evolutionary computing. It also explores the impact of nature-inspired computing on scientific progress.
Course Outcomes (COs):

CO-1. Algorithmic Proficiency: Gain a thorough understanding of various nature-inspired computing algorithms, such as genetic algorithms, particle swarm optimization, and ant colony optimization, and their applications in data science tasks.

CO-2. Problem-Solving Skills: Develop the ability to apply nature-inspired computing techniques to solve complex optimization, machine learning, and robotics problems encountered in data science domains.

CO-3. Critical Analysis: Evaluate the strengths, limitations, and suitability of different nature-inspired computing algorithms for various data science scenarios, enabling informed algorithm selection.

CO-4. Application Versatility: Apply nature-inspired computing methods to real-world data sets, demonstrating the practical implementation and adaptation of these techniques to address diverse data science challenges.

CO-5. Interdisciplinary Insight: Understand the interdisciplinary nature of nature-inspired computing and its contributions to the advancement of both computational intelligence and natural sciences, fostering a holistic view of algorithmic innovation.

CO-PO/PSO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C0 1	2	2	2	2									3	3	3
CO 2	3	3	3	2									3	3	3
CO 3	3	3	3	3									3	3	3
CO 4	2	2	3	2									3	3	3
CO 5	3	2	3	3									3	3	3

Course Content:
Module 1: Introduction to Nature Inspired Computing and Philosophy

- From Nature-to-Nature Computing: Exploring the transition from natural systems to computing paradigms.
- Philosophy and Concepts: Understanding the philosophy behind nature-inspired computing.

- Overview of Three Branches: Evolutionary Computing, Swarm Intelligence, and Immuno-computing.
- Parallelism and Distributivity: Studying parallel and distributed computing in nature-inspired models.
- Interactivity, Adaptation, and Feedback: Examining the concepts of interactivity and feedback in natural systems.
- Self-Organization and Complexity: Understanding self-organization and complex behaviours in nature.
- Emergence and Complexity: Exploring emergent properties and complexity in natural phenomena.
- Determination, Chaos, and Fractals: Discussing the balance between deterministic and chaotic behaviours in nature.

Module 2: Computing Inspired by Nature: Evolutionary Computing

- Introduction to Evolutionary Computing: Understanding the inspiration from evolutionary biology. Example of Hill Climbing and Simulated Annealing: Exploring optimization techniques based on natural processes.
- Genetics Principles: Studying genetic principles for problem-solving.
- Standard Evolutionary Algorithm - Genetic Algorithms: Detailed examination of genetic algorithms.
- Reproduction, Crossover, and Mutation: Key genetic operators for generating new solutions.
- Evolutionary Programming and Genetic Programming: Introducing evolutionary programming and genetic programming for problem-solving.

Module 3: Swarm Intelligence and Ant Colony Optimization

- Introduction to Swarm Intelligence: Understanding collective behaviours in social organisms.
- Ant Colony Optimization: Exploring the foraging behaviour of ants and its optimization applications.
- SACO (Self-Adaptive Cooperative Optimization): Scope and applications of self-adaptive cooperative optimization.
- Ant Colony Algorithm (ACA): Detailed study of the ant colony algorithm.
- Swarm Robotics and Social Adaptation: Applying swarm intelligence to robotics and social systems.
- Particle Swarm Optimization (PSO): Introduction to particle swarm optimization for optimization tasks.

Module 4: Immuno-computing and Artificial Immune Networks

- Introduction to Immuno-computing: Understanding immune system principles for computing.
- Physiology and Components: Exploring the components of the immune system.
- Pattern Recognition and Immune Algorithms: Applying pattern recognition to problem-solving.
- Immune Network Theory and Danger Theory: Studying immune network theory and the danger theory.
- Evaluation, Interaction, and Immune Algorithms: Examining the evaluation and interaction of immune algorithms.
- Bone Marrow Models and Forest's Algorithm: Detailed study of bone marrow models and forest's algorithm.
- Artificial Immune Networks: Introduction to artificial immune networks for optimization.

Module 5: Computing with New Natural Materials and DNA Computing

- DNA Computing: Motivation and principles behind DNA-based computing.
- DNA Molecule and Adleman's Experiment: Exploring the DNA molecule and Adleman's groundbreaking experiment.

- Test Tube Programming Language and Universal DNA Computers: Discussing programming languages and universal DNA computers.
- PAM Model and Splicing Systems: Introduction to the PAM model and splicing systems in DNA computing.
- Lipton's Solution to SAT Problem: Understanding Lipton's contribution to solving the SAT problem using DNA computing.
- Scope of DNA Computing: Exploring the potential applications and scope of DNA computing.
- From Classical to DNA Computing: Comparing classical computing with DNA-based computing.

Recommended Text Books

9. "Nature-Inspired Optimization Algorithms" by Xin-She Yang
10. "Swarm Intelligence: Principles, Advances, and Applications" by Maurice Clerc

Recommended Reference Books

9. "Artificial Immune Systems: A New Computational Intelligence Approach" by Dipankar Dasgupta
10. "DNA Computing and Molecular Programming: 25th International Conference, DNA 25, Burlington, VT, USA, September 19–23, 2019, Proceedings" edited by Luca Cardelli, Andrew Phillips

Course Name: BIO-INFORMATICS
Course Code: CS(DS)801B
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
CS(DS)801B.1	To acquire the knowledge of Bioinformatics technologies with the related concept of DNA, RNA and their implications
CS(DS)801B.2	To develop idea in MOLECULAR BIOLOGY
CS(DS)801B.3	To understand the concept and techniques of different types of Data Organization and Sequence Databases with different types of Analysis Tools for Sequence Data Banks
CS(DS)801B.4	To acquire the knowledge of the DNA SEQUENCE ANALYSIS
CS(DS)801B.5	To analyze the performance of different types of Probabilistic models used in Computational Biology

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CS(DS)801B.1	3	-	-	-	-	1	1	-	-	-	-	-	-	-	-
CS(DS)801B.2	-	1	2	1	-	-	-	-	-	1	-	2	-	-	-
CS(DS)801B.3	1	2	-	-	2	-	-	-	1	-	-	-	-	-	-
CS(DS)801B.4	2	-	-	-	-	2	2	-	-	2	1	-	-	-	-
CS(DS)801B.5	-	3	-	1	-	3	-	1	-	-	2	-	-	-	-
	0.75	0.75	0.4	0.4	0.4	0.75	0.6	0.2	0.2	0.6	0.6	0.4	-	-	-

Course Content:

Module -1: [7L]
INTRODUCTION TO MOLECULAR BIOLOGY: Concepts of Cell, tissue, types of cell, components of cell, organelle. Functions of different organelles. Concepts of DNA: Basic Structure of DNA; Double Helix structure; Watson and crick model. Exons and Introns and Gene Concept. Concepts of RNA: Basic structure, Difference between RNA and DNA. Types of RNA. Concept of Protein: Basic components and structure. Introduction to Central Dogma: Transcription and Translation, Introduction to Metabolic Pathways. Introduction to Bioinformatics. Recent challenges in Bioinformatics.

Module -2: [10L]
Introduction to Genomic data, Data Organization and Sequence Databases: Sequence Data Banks - Introduction to sequence data banks - protein sequence data bank. Signal peptide data

bank, Nucleic acid sequence data bank - GenBank, AIDS virus sequence data bank. RRNA data bank, structural data banks - protein Data Bank (PDB), The Cambridge Structural Database (CSD) : Genome data bank - Metabolic pathway data : Microbial and Cellular Data Banks. Introduction to MSDN (Microbial Strain Data Network):Numerical Coding Systems of Microbes, Hibridoma Data Bank Structure, Virus Information System Cell line information system; Protein Sequence Databases, DNA sequence databases. sequence database search programs like BLAST and FASTA. NCBI different modules: GenBank; OMIM, Taxonomy browser, PubMed;

Module 3: [8L]

DNA SEQUENCE ANALYSIS DNA Mapping and Assembly: Size of Human DNA , Copying DNA: Polymerase Chain Reaction (PCR), Hybridization and Microarrays, Cutting DNA into Fragments, Sequencing Secondary Structure predictions; prediction algorithms; Chao-Fasman algorithm, Hidden-Markov model, Neural Networking. Tertiary Structure predictions; prediction algorithms; Chao-Fasman algorithm, Hidden-Markov model, Neural Networking.

Module -4: [10L]

Introduction Probabilistic models used in Computational Biology: Probabilistic Models; Gene Regulatory Method Application of HMM in Bioinformatics: Genefinding, profile searches, multiple sequence alignment and regulatory site identification. Applications in Biotechnology: Protein classifications, Fold libraries, Protein structure prediction: Fold recognition (threading), Protein structure predictions : Comparative modeling (Homology), Advanced topics: Protein folding, Protein-ligand interactions, Molecular Modeling & Dynamics, Drug Designing.

Text book:

3. Yi-Ping Phoebe Chen (Ed), ―BioInformatics Technologies‖, First Indian Reprint, Springer Verlag, 2007.

Reference Books:

1. Bryan Bergeron, ―Bio Informatics Computing‖, Second Edition, Pearson Education, 2003.
2. Arthur M Lesk, ―Introduction to Bioinformatics‖, Second Edition, Oxford University Press, 2005

Course Name: ROBOTICS
Course Code: EC(DS)801C
Contact (Periods/Week):=3L/Week
Total Contact Hours: 36
Credits: 3

Pre-requisite:
1. Microprocessor & Microcontroller
2. Computer Organization & Architecture

Course Outcomes: After attending the course students should be able to

Course Outcomes	Name of Course Outcomes
EC(DS)801C.1	To describe and explain the microcontrollers used the in robots.
EC(DS)801C.2	To design the software and build the prototype of robots.
EC(DS)801C.3	To apply localization and mapping aspects of mobile robotics.
EC(DS)801C.4	To demonstrate self-learning capability.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC(DS)801C.1	3	3	-	1	2	-	-	-	-	-	-	-	-	-	-
EC(DS)801C.2	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-
EC(DS)801C.3	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EC(DS)801C.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	2.25	2.75	0.75	0.75	0.5	-	-	-	-	-	-	-	-	-	-

Course Content:

Module 1[5L]
Brief history, types, classification and usage, Science and Technology of robots, Some useful websites, textbooks and research journals. Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Module 2 [8L]
Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial

manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator. Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop- closure equations, Direct kinematics problem, Mobility of parallel manipulators, Closed-from and numerical solution, Inverse kinematics of parallel manipulators and mechanisms, Direct kinematics of Gough-Stewart platform.

Module 3[8L]
Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics. Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators.

Module 4[9L]
Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators.

Module 5[5L]
Introduction and some well known wheeled mobile robots (WMR), two and three-wheeled WMR on flat surfaces, Slip and its modeling, WMR on uneven terrain, Design of slip-free motion on uneven terrain, Kinematics, dynamics and static stability of a three-wheeled WMR_s on uneven terrain, Simulations using Matlab and ADAMS. Introduction to chaos, Non-linear dynamics and chaos in robot equations, Simulations of planar 2 DOF manipulators, Analytical criterion for unforced motion. Gough-Stewart platform and its singularities, use of near singularity for fine motion for sensing, design of Gough-Stewart platform based sensors. Over-constrained mechanisms and deployable structures, Algorithm to obtain redundant links and joints, Kinematics and statics of deployable structures with pantographs or scissor-like elements (SLE_s).

Text book:

1. Myke Predko, ―Programming Robot Controllers‖ – McGrawHill, 1st edition, 2003.

Reference Books:

1. Michael slater, ―Microprocessor – based design: A comprehensive Guide to Effective Hardware Design, Prentice Hall, 1989.
2. Myke Predko, ―Programming and customizing the 8051- micro-controller‖, Tata McGraw-Hill, New Delhi, 2000.