Institute of Engineering and Technology

HAND BOOK

On

CURRICULUM STRUCTURE AND SYLLABUS

Bachelor of Technology

in

Computer Science and Artificial Intelligence

(Programme Code: 3109)

Batch: 2023-27

CONTENTS

JK Lakshmipat University, Jaipur
Institute of Engineering and Technology
Curriculum Structure
Bachelor of Technology in Computer Science Artificial Intelligence (Batch 2023-2027)

Sem.	Courses						Credit
I	Programming- I	Fundamentals of Electrical and Electronics Engineering	Electromagnetism and Quantum Mechanics / Environmental Studies	Calculus	Engineering Drawing	Fundamentals of Communications	
	4	4	3	4	3	2	**20**
II	Programming- II	Digital Circuit and Systems	Electromagnetism and Quantum Mechanics / Environmental Studies	Linear Algebra and Differential Equations	Design Thinking	Critical Thinking and Storytelling	
	4	4	3	4	3	2	**20**
III	Data Structures and Algorithms	Computer Organisation and Architecture	Database Management Systems	Probability and Statistics	Essentials of Management and Business	Perspectives on Contemporary Issues	
	4	4	4	4	3	2	**21**
IV	Design and Analysis of Algorithms	Machine Learning	Operating Systems	Optimization for Computer Science	Managing Business Functions	Communication and Identity	
	4	4	4	4	3	2	**21**
Practice School 1							**4**
V	Discrete Mathematics	Artificial Intelligence	Deep Learning	DE-I	OE-I /SEE(1) +SEE(2)	Understanding and Managing Conflicts	
	4	4	4	4	4	2	**22**
VI	Reinforcement Learning	Ethics in AI	Minor Project	DE-II	OE-II/SEE(1)+SEE(2)	Critical Thinking for Decisions at Workplace	
	4	4	2	4	4	2	**20**
VII	Project	OE-III	DE-III	DE-IV	OE-IV		
	4	4	4	4	4		**20**
VIII	Practice School-II /Entrepreneurial Project/Research Project/Semester at a partner University						**16**
	Total Credits						**164**

List of Electives	
Department Electives- I, II, III, IV	**Open Electives I, II, III**
Artificial Intelligence for Social Good	Idea to business model
Mining Massive Data Sets	Numerical and scientific computing
Large Language Models	Advanced statistics
Artificial Intelligence in Healthcare	Introduction to Robotics
Regulations Governing AI	Integrating design, technology and business
Deep Learning for Natural Language Processing	Introduction to IoT and Automation project
Deep Learning for Computer Vision	Computational game theory and applications
Deep Learning for Spoken Language Processing	Smart Materials
Deep Reinforcement Learning	Fundamental of sustainable development
Deep Generative Models	Motion Planning, Control, and Manipulation of Robots
Generative Adversarial Networks	Project in Robotics
	Mechanics of Robots
	Flexible Electronics
	Neuromorphic Engineering
	Digital Logic Verification
SEE-I, II	Mechanisms for Machines
Virtual Reality Lab	Fundamentals of investing
Geographical Information Systems Lab	Operations research
Robotic Process Automation Lab	Behavioral assessments for employability
Google Cloud Lab	Solid and e-waste management
	Disaster management

Departmental electives of CS branch may also be taken as departmental electives for CS+AI.

INDEX OF COURSE DESCRIPTIONS

Semester VI			
34	CS1141	Reinforcement Learning	3-1-0
35	CS1142	Ethics in AI	4
36	PR1103	Minor Project	2
37	-	Department Elective - II	4
38	-	Open Elective – II / SEE(1) + SEE(2)	4
39	CC1106	Critical Thinking for Decisions at Workplace	2-0-0
Semester VII			
40	PR1107	Project	4
41	-	Department Elective – III	4
42	-	Department Elective - IV	4
43	-	Open Elective - III	4
44	-	Open Elective - IV	4
Semester VIII			
45	PS1102/ PR1105/ PR1104	Practice School-II/Entrepreneurial Project/Research Project/Semester at a partner University	16

Department Electives		
1	CS1229	Artificial Intelligence for Social Good
2	CS1230	Mining Massive Data Sets
3	CS1231	Large Language Models
4	CS1232	Artificial Intelligence in Healthcare
5	CS1233	Regulations Governing AI
6	CS1234	Deep Learning for Natural Language Processing
7	CS1235	Deep Learning for Computer Vision
8	CS1236	Deep Learning for Spoken Language Processing
9	CS1237	Deep Reinforcement Learning
10	CS1238	Deep Generative Models
11	CS1239	Generative Adversarial Networks

Open Electives			
1	ED1102	Idea to business model	4-0-0
2	AS2202	Numerical and scientific computing	3-0-2
3	AS1202	Advanced statistics	3-1-0
4	ME1226	Introduction to Robotics	3-0-2
5	IL1211	Integrating design, technology and business	4
6	EE1222	Introduction to IoT and automation project	2-1-2
7	EE1223	Computational game theory and applications	3-1-0
8	ME1228	Smart Materials	3-0-2
9	ME1227	Fundamental of sustainable development	3-1-0
10	ME1222	Motion Planning, Control, and Manipulation of Robots	3-0-2
11	ME1223	Project in Robotics	1-0-6

12	ME1224	Mechanics of Robots	3-0-2
13	EE1225	Flexible Electronics	3-1-0
14	EE1226	Neuromorphic Engineering	3-1-0
15	EE1227	Digital Logic Verification	3-0-2
16	IL1206	Mechanisms for Machines	3-0-2
17	IL1211	Integrating design, technology and business	4
18	FA1127	Fundamentals of investing	4-0-0
19	AS1201	Operations research	3-0-2
20	BS1105	Behavioral assessments for employability	4-0-0
21	AS1210	Solid and e-waste management	3-1-0
22	CE1206	Disaster management	3-1-0

Skill Enhancement Electives			
1	CS1221	Virtual Reality Lab	0-0-4
2	CE1114	Geographical Information Systems Lab	0-0-4
3	CS1125	Robotic Process Automation Lab	0-0-4
4	CS1223	Google Cloud Lab	0-0-4

Course Title and Code: Programming I (Python) (CS1133)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. I Sem
Prerequisite	None
Weightage	Theory 60%, Lab 40%

Course Objectives: The aim of the course is to build up a clear understanding of the fundamentals of computer programming. The course is taught using Python programming language. The course will discuss and cover the topics necessary for the students to write, execute and understand the programs on their own. The students will be able to demonstrate problem solving skills by developing and implementing algorithms to solve problems.

Learning Outcomes:

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

1. Demonstrate problem solving skills in Python by designing and implementing basic computing techniques and algorithms.
2. Understand the basic programming syntax; tokens, operators, variables, data types and expressions. Identify different object-types.
3. Use Python control constructs and decision-making structures for writing programs.
4. Use lists, tuples, dictionaries, functions, strings for solving problems.
5. Use third-party Python packages and create our own packages or modules for reusability.
6. Understand data/file handling techniques, exception handling and basic OOP concepts in Python

Course Syllabus (Theory):

Basics of Computer Programming: Flowcharts, Algorithms, Writing pseudocode, computational thinking.

Fundamentals of Python: Beginnings with Python, Parts of a Program: Modules, Statements and Expressions, Whitespace, Comments, Special Python Elements: Tokens, Naming Objects, Variables, Objects and Types, Operators;

Control: The Selection Statement for Decisions: if,

Repetition: for Statement, In-Depth Control: Boolean Variables, Relational Operators, Boolean Operators, Precedence, while Statement, Nesting.

Functions: What Is a Function? Python Functions, Flow of Control with Functions, Scope, Arguments, Parameters, Default Values and Parameters, Functions as Objects;

Introduction to *Classes*: Object-Oriented Programming, Characteristics of OOP, Class and Instance, Object Methods, Fitting into the Python Class Model, Python and OOP, Python and Other OOP Languages, Classes, Inheritance.

Strings: The String Type, String Operations, Formatted Output for Strings;

Lists and Tuples: What Is a List? Iteration, Indexing and Slicing, Operators, Lists vs Strings, Split and Other Functions and Methods, Anagrams, Tuples from Lists.

Dictionaries and Sets: Dictionaries, Python Dictionaries, Dictionary Indexing and Assignment, Sets, Python Sets, Methods, Operators, and Functions for Python Sets, Set Methods;

Files and Exceptions: What Is a File? Accessing Files: Reading Text Files, Accessing Files: Writing Text Files, Reading and Writing Text Files in a Program, File Creation and Overwriting, Handling Errors: Error Names, the try-except Construct, try-except Flow of Control, Exception;

Reference Books:

1. David I. Schneider, 'An Introduction to Programming using Python' Pearson, 2016.
2. John V. Guttag, 'Introduction to Computation and Programming Using Python – with Applications to

Computational Modeling and Understanding Data', MIT Press, 3rd Edition, 2021.
3. William Punch, Richard Enbody, 'The Practice of Computing Using Python'. Pearson, 2016.
4. Allen B. Downey. Think Python. Green Tea Press, Massachusetts, USA.

Reference Online Course:

Programming for Everybody (Getting started with Python)
https://www.coursera.org/learn/python
https://www.coursera.org/specializations/python
Python 3: Programming Specialization
https://www.coursera.org/specializations/python-3-programming

Course Title and Code: Fundamentals of Electrical and Electronics Engineering (EE1118)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. I semester (CSE, CCE, CSE+AI)
Prerequisite	None
Weightage	Theory -70%, Practical and Projects – 30%
Course Objectives: This course aims to provide conceptual knowledge about electrical circuits and electronic devices and their real-life applications. It provides an overview of digital communication concepts and modulation techniques.	
Learning Outcomes: On successful completion of this course, the students should be able to: 1. Understand the behavior of active and passive components. 2. Develop applications using various type of diodes. 3. Use the small signal model to study the amplifiers. 4. Design switching circuits using MOSFETs. 5. Familiarize with modulation techniques used for digital communication.	

Course Syllabus (Theory)

Unit 1: Introduction to discrete components and abstractions on which design of electronic circuits are based. Sinusoidal steady state analysis of circuits containing resistors, capacitors, and inductors. Differential equations describing time and frequency behavior of circuits containing storge elements.
Unit 2: Circuit Analysis Techniques- KVL, KCL, Source Transformations, Network theorems.
Unit 3: Semiconductor, Diode, PN junctions, Diode equation and models.
Unit 4: BJT and MOSFET-construction and biasing, small signal model- BJT/MOSFET as a switch. Amplifiers- Transconductance Model, Magnitude and Phase response. MOSFET as invertor and switch. Operational amplifier and its applications.
Unit 5: Communication Systems: Various frequency bands used for communication, Block diagram of Digital communication, need of modulation, Digital modulation techniques (ASK, FSK, PSK).

Textbooks:

1. Engineering Circuit Analysis by WH Hayt, JE Kemmerly, SM Durbin, Tata Mc Graw Hill Education Private Limited.
2. Microelectronics Circuits by Adel S Sedra and Kenneth C Smith, Oxford Press.
3. Electronic Communication Systems by G.Kennedy, McGrawHill,4th Edition.

Course Title and Code: Electromagnetism and Quantum Mechanics (AS1108)	
Hours per Week	**L-T-P: 3-0-0**
Credits	**3**
Students who can take	B.Tech. I Sem
Prerequisite	None
Weightage	Theory 100%

Course Objectives: The objective of the course is to: Formulate electromagnetic phenomena for static configurations and describe them using vector calculus; determine electric field in vacuum and matter and magnetic field in vacuum and determine the associated energy; describe unification of electric and magnetic field and Maxwell's equations; formulate propagation of electromagnetic waves and their reflection and transmission at change of medium.

Understand the dual nature of light and matter and the need of Quantum Mechanics; formulate quantum mechanics and apply it to simple systems to understand nature at atomic scale, formulate basic ideas of Quantum Mechanics with states and operations in Hilbert space

Learning Outcomes:

On successful completion of this course, the students should learn to

1. For a given charge (current) distribution, find the electric (magnetic) field in vacuum. Find electric fields in matter.
2. Use vector calculus for describing basic electromagnetic phenomena leading to Maxwell's equations.
3. Use polarised wave solution of electromagnetic wave equation and find reflection and transmission of electromagnetic wave incident upon a medium.
4. Determine the need for new Physics from dual nature of light and matter and write Schroedinger equation.
5. Use Schroedinger equations to solve bound state problems in some simple potentials.
6. Using results of simple harmonic oscillator, show that classical physics is a limiting case of quantum physics.
7. Solve the problem of scattering of a particle by a potential and determine transmission and reflection probabilities and apply quantum mechanical tunnelling in other fields.

Course Syllabus (Theory):

Recapitulation of Electrostatics, Vector Analysis and Electrostatics using vector calculus, electric potential, discrete and continuous charge distribution, electrostatic energy, conductors, Field of an electric dipole, Multipole expansion of charge distribution, Electric Fields in Matter, Polarisation and field of polarized object and inside dielectric, Linear dielectrics and properties.

Magnetostatics: force law, field due to steady current, divergence and curl of magnetic field, magnetic vector potential and field of a rotating spherical shell with surface charge, Force and torque due to magnetic fields, magnetization, magnetic moment and energy.

Electromagnetic Induction, Maxwell's equations, Energy of electromagnetic field and Poynting theorem. EM wave equation, formulation of wave propagation in one dimension, reflection, transmission, polarization. Electromagnetic Waves in vacuum and through linear media, Reflection and Transmission of EM waves, Snell's law, Total Internal Reflection.

Blackbody radiation, photoelectric effect and particle nature of light. Matter waves, Davisson- Germer experiment, Wave function and Schroedinger equation, Properties, interpretation and admissibility conditions on wave function, free particle equation and wave packet, uncertainty principle. Two slit interference experiment for electrons, measurement and interpretation.

Time Independent Schroedinger equation for bound state; infinite and finite square well, double potential well and many wells leading to formation of bands in solids (qualitative), one-dimensional harmonic oscillator --- solution using creation annihilation operators, discussion of eigenvalues and eigenfunctions taken from analytical solution (no derivation of eigenfunction or eigenvalues), correspondence principle.

Schroedinger equation for H-atom, discussion of energy eigenvalues and radial eigenfunctions (qualitative --- no derivation), Zeeman effect and space quantization of angular momentum, Angular momentum, commutation relations, raising and lowering operators and its eigenvalues, Spin angular momentum, Pauli spin matrices, Stern Gerlach experiment and spin.

Scattering from rectangular potential well and rectangular potential barrier, transmission and reflection, tunnelling, qualitative discussion of applications in nuclear physics and electronics.

Functions as vectors, Postulates of Quantum Mechanics and a brief introduction to vector space and bra and ket vector formalism, Introduction to quantum qubits and quantum gates, base states and superposed states.

The scope of the Electromagnetism part of the syllabus is from parts of chapters 1-9 of *Introduction to Electrodynamics by David Griffiths.* The scope of the major part of Quantum Mechanics in the syllabus is from parts of chapters 1-4 of *Introduction to Quantum Mechanics by David Griffiths.* Covering the topics marked with asterisk will be optional, and will depend on the pace of the class.

Reference Books:

1. Classical Electromagnetism by H.C.Verma
2. A Textbook of Quantum Mechanics by P.M.Mathews and K. Venkatesan

Course Title and Code: **Environment Studies ES1114**	
Hours per Week :	**L-T-P: 3-0-0**
Credits	**3**
Students who can take	BTech & BCA I Semester
Prerequisites	Basic science
Weightage	Theory -70% Practical -30%

Course Objectives: The primary goal of this course is to deepen participants' comprehension of the multidisciplinary aspects of the environment. It aims to explore diverse sources of natural energy, delve into the intricate workings of ecosystems, and foster an awareness of today's pressing environmental challenges. Through comprehensive study and analysis, this course seeks to broaden understanding and promote sustainable practices for a better future.

Learning Outcomes:

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

1: Relate renewable energy with ecology and the environment.

2: Assess climate change and its threat to biodiversity and the ecosystem.

3: Identify various pollution sources and their impact on the Environment.

4: Understand and apply sustainable development principles and various environmental Protection acts.

Course Syllabus (Theory):

UNIT-1 Introduction: Understanding the environment, Global crisis, Basic Concepts of the multidisciplinary nature of environmental studies, Need for public awareness.

UNIT-2: Natural Resources

Renewable and non-renewable resources, Natural resources and associated problems, Water resources, Mineral resources, Food resources, and Energy resources.

UNIT-3: Ecosystems

Concept of an ecosystem, Structure, and function of an ecosystem, types of ecosystems, Producers, consumers and decomposers, Food chains, food webs, and ecological pyramids. Introduction to Biodiversity, Value of Biodiversity, Hot Spot of Biodiversity, Threats to Biodiversity, Biodiversity Conservation.

UNIT-4: Environmental Pollution

Definition, Cause, effects, and control measures of Air pollution, Water pollution, Soil pollution, and Marine pollution, Solid waste Management: Causes, effects, and control measures of urban and industrial wastes.

UNIT-5: Social Issues and the Environment:

From Unsustainable to Sustainable development, urban problems related to energy, Water conservation, Greenhouse gases & Climate change, global warming, acid rain, and ozone layer depletion. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.

Reference:

1. Rajagopalan, R., "Environmental Studies: From Crisis to Cure", Oxford University Press, New Delhi, 2e, 2011
2. Ranjit Daniels & J. Krishnaswamy "Environmental Studies", Wiley India
3. Davis & Cornwell "Environmental Engineering", McGraw Hill
4. W. Cunningham – Principles of Environmental Science, TMH
5. P. Venugoplan Rao – Principles of Environmental Science and Engineering, PHI.

Video Lectures:

1. http://www.nptelvideos.in/2012/12/fundamentals-of-environmental-pollution.html

2. http://www.nptelvideos.in/2012/11/energy-resources-and-technology.html
3. https://nptel.ac.in/courses/122/102/122102006/
4. https://nptel.ac.in/courses/127106004/

Websites (related to the course)

1. http://www.cpcb.nic.in/
2. http://www.rpcb.rajasthan.gov.in
3. http://www.bis.org.in/
4. http://www.who.int/en/
5. http://www.moef.gov.in

Course Title and Code: Calculus (AS1109)	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Students who can take	B. Tech I Sem
Prerequisites	None
Weightage	Theory – 100%

Course Objectives: This course introduces the various forms of calculus useful in diverse engineering areas. The course builds upon the concepts learned in single-variable calculus and extends to the functions of several variables. Propositional calculus covers the basic concepts of mathematical logic useful for students in computer science courses.

Learning Outcomes:

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

1. use the concepts of limits and convergence to analyze the sequences and series of real numbers.
2. define, analyze, and visualize functions of multiple variables.
3. apply higher-dimensional differential calculus methods to a range of physical problems including optimization.
4. use the concept of the gradient and its relationship to directional derivatives to analyze vector fields and scalar fields geometrically.
5. use propositional calculus to read, comprehend and construct mathematical logic and arguments.

Course Syllabus (Theory):

Differential Calculus

Infinite Series: Convergence of sequences and series of real numbers, absolute and conditional convergence, comparison, ratio and root tests for convergence, power series.

Function of several variables: Review of functions of one variable, curve sketching, limit, continuity, partial derivatives, differentiability, linearization, maxima-minima.

Integral Calculus

Arc length, Solids of Revolution: Surface Area and Volume, Double integrals, change of order of integration, Change of variables (Cartesian to Polar and vice versa), triple integrals.

Vector Calculus

Vector Differentiation: Vector functions and derivatives, arc length and unit tangent vector, curvature and unit normal vector, directional derivative and gradient vectors, tangent plane, divergence, and curl of a vector field.

Propositional Calculus

Proposition, Compound Proposition, Conjunction, Disjunction, Implication, Converse, Inverse & Contrapositive, Bi-conditional Statements, Mathematical Proof Methods

Textbooks:

1. George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, 9th Edition, Pearson Education Asia, 2006.
2. Kenneth H. Rosen, Discrete Mathematics and its Applications, 7th Edition, McGraw Hill, 2012.

Reference Books:

1. C. Ray Wylie and Louis Barrett, Advanced Engineering Mathematics, 6th edition, McGraw Hill, 2003.
2. Monty J. Strauss, Gerald L. Bradley, and Karl J. Smith. Calculus, 3rd edition, Pearson Education India, 2002.

Course Title and Code: Engineering Drawing (ME1103)	
Hours per Week	**L-T-P: 2-0-2**
Credits	**3**
Students who can take	B.Tech. I Semester
Prerequisites:	None
Weightage	Theory -60%, Practical and Assignments – 40%
Course Objectives: This course effectively conveys and develop the engineering drawing concepts. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, by using the most generally used CAD application software, AutoCAD.	
Learning Outcomes: On successful completion of this course, the students should be able to: Read and interpret engineering drawings. Identify the three principal projection planes. Draw 2-dimensional orthographic projections. Create an isometric drawing using CAD Tool.	

Course Syllabus (Theory):

UNIT – I

Introduction to Engineering Drawing, Orthographic Projections:

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Scales – Plain and Diagonal Scales. **(8 lectures)**

UNIT – II

Projection of points and lines

First angle projection, projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes. **(6 lectures)**

UNIT – III

Projection of plane surface and solid

Projection of simple solids like prisms, pyramids, cylinder, cone, and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. **(10 lectures)**

UNIT – IV

Drawing using AutoCAD:

Introduction to AutoCAD, drawing commands, editing commands, annotate commands, layers. Drafting using AutoCAD**,** Layout, view arrangements, dimensioning, annotation, bill of materials. **(16 lectures).**

Text Books:

1. Bhatt, N. D. (2011). Engineering Drawing (5th ed.). Anand, India: Charotar Publishing Co.
2. "Engineering Graphics" by K.L. Narayana and P. Kannaiah, Scitech Publications (India), Pvt. Ltd., October 2008.
3. Engineering Drawing & Design: Cencil Jensen, Jay D. Helsel, Dennis R. Short, Seventh Edition, Tata Mcgraw Hill 2012.

Reference Online Course: https://nptel.ac.in/courses/112103019

Course Title and Code: Fundamentals of Communication (CC1101)	
Hours per Week	**L-T-P: 2-0-1**
Credits	**2**
Students who can take	B.Tech/BCA/BBA/BDes Sem I
Prerequisites	None
Weightage	Theory 40% Practical 60%

Course Objectives- This course provides an introduction to the importance of effective communication, the consequences of poor communication, and the different elements of verbal and non-verbal communication. Students learn about, and enhance, the components of communication: kinesics, paralanguage (voice) and language.

Course Outcomes:

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

Identify cultural differences and their impact on communication.

Deliver effective oral presentations following appropriate kinesics and paralinguistic features.

Compose grammatically correct sentences and paragraphs to write effective emails and essays.

Identify common language errors and take steps to avoid them.

Apply appropriate communication skills across settings, purposes, and audiences.

Module(s)	Topics to be covered
Basics of Communication	• Nature and Importance of Communication • Mehrabian's Communication Theory • Ethos, Pathos, Logos: The Three Pillars of Persuasive Communication • Consequences of Poor Communication • Influence of Culture on Communication
Public Speaking and Presentation Skills	• Formats of Public Speaking (oral narration, conversational skills) • Basics of Effective Presentations • 4 Ps of Presentations • The Power of Three
Writing Skills	• Structuring Better Paragraphs • Writing Strategy • Email and Formal Writing • Writing Essays
English	• English as a Foreign Language • World Englishes • English Pronunciation • Common errors in English

Reference Books:

- Raman, Meenakshi and Sangeeta Sharma, 2011. Technical Communication: Principles and Practice. Second Edition. New Delhi: Oxford University Press.

- Mohan, Krishna and Meenakshi Raman. 2010. Advanced Communicative English. New Delhi: Tata McGraw Hill.

- "The Quick And Easy Way To Effective Speaking" by Dale Carnegie
- "Effective Speaking Skills" by Terry O' Brien
- "Communication Skills: A Practical Guide to Improving Your Social Intelligence, Presentation, Persuasion and Public Speaking" by Ian Tuhovsky

Recommended MooCs :

1. English for the Workplace (Offered By British Council)
   https://www.futurelearn.com/courses/workplace-english

2. Rhetoric: Art of Persuasive Writing and Public Speaking (Offered by Harvard University)
   https://online-learning.harvard.edu/catalog?keywords=Rhetoric&op=Search

Course Title and Code: Programming II (CS1135)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. CSE II, V (DE) Sem, BCA III Semester
Prerequisite	None
Weightage	Theory 60% Lab 40%

Course Objectives: The purpose of this course is to introduce to students to the field of programming using C language. The students will be able to enhance their analysing and problem solving skills using functional Programming language.

Learning Outcomes:

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

1. Design solutions to simple mathematical and engineering problems by applying the basic programming principles of C language.
2. Problem-solving through structures, unions and files.
3. Apply code reusability with functions and pointers.
4. Develop an in-depth understanding of functional and logical concepts of C Programming.
5. Understand and analyze problems, develop and implement algorithms to solve it.

Course Syllabus (Theory)

UNIT I

Overview of C: History and importance of C, Basic structure of C program, executing a C program. Data Types and Operators, Variables, Sequences and Iteration Different types of Data types, Expressions, Precedence Rules, Operators- Operators: arithmetic operators, relational operators, logical operations, bitwise operators, miscellaneous operators, Local Variables, Global Variables.

UNIT II

Conditional Statements, Loops, Arrays and Strings, User Defined Data Types If-else statement, For loop, While Loop, Nested Iteration, Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays, different types of user defined data types, Character Arrays and Strings: Declaring and Initializing String Variables, Reading Strings from Terminal, Writing Strings to Screen, Arithmetic Operations on Characters, String-handling Functions.

Unit III

Functions in C, Passing Parameters (By value & Reference), using returned data, Passing arrays, structures, array of structures, pointer to structures etc., passing characters and strings, The void pointer.

UNIT IV

Pointers, Using pointers to represent arrays, Dynamic Memory allocation, structures, using typedef, Pointers: What is a Pointer? - How do you Define a Pointer? - Pointer Indexing – Pointer Arithmetic - Function data return with a Pointer - A pointer to a Function, Arrays of Structures & pointers Pointer Expressions, Pointer Increments and Scale Factor.

UNIT V

Files — Types of file processing: Sequential access, Random access — Sequential access file –Random access file –Command line arguments

Structure – Nested structures — Pointer and Structures — Array of structures — Example Program using structures and pointers — Self-referential structures — Dynamic memory allocation – Singly linked list – typedef.

TEXT BOOKS:

T1. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.
T2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCES:

R1. ReemaThareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
R2. Griffiths, D., & Griffiths, D. (2012). Head First C: A Brain-Friendly Guide. " O'Reilly Media, Inc.".
R3. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018.

Reference Online Material-

Introductory C Programming Specialization
https://www.coursera.org/specializations/c-programming
C for Everyone: Programming Fundamentals
https://www.coursera.org/learn/c-for-everyone

JAVATPOINT
C Programming Language
https://www.javatpoint.com/c-programming-language-tutorial
GeeksforGeeks
C Programming Language
https://www.geeksforgeeks.org/c-programming-language/

Course Title and Code: Digital Circuit and Systems (EE1120)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. II Semester
Prerequisite	None
Weightage	Theory -70%, Practical and Projects – 30%

Course Objectives: This course aims to impart fundamental knowledge about digital logic and circuits which lead to design of complex digital systems like microprocessors. This is the foundation course by which students get exposure to design of digital logic systems.

Learning Outcomes:

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

1. To represent logical functions in canonical and standard form.
2. Evaluate and simplify Boolean functions and implement the minimized logic using logic gates/Programmable logic arrays.
3. To design and analyse combinational logic circuits using minimum gates.
4. Analyse the timing behaviour (circuits (clock skews, propagation delays, Setup and Hold Times). of sequential logic.
5. Develop Finite State Machine models for some real-life digital systems.

Course Syllabus (Theory):

Introduction to Digital electronic systems- examples of some real-life applications.

Number Systems, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms.

Combinational systems. Logic gates and TRI-STATE logic. The Map Method - K-map, Product of Sums and Sum of Products Simplification, NAND and NOR Implementation of various logic circuits using CMOS.

Arithmetic blocks. Magnitude Comparator, Multiplexers, Demultiplexers, Encoder, Decoders, Parity Checkers, Implementation of Boolean functions using Multiplexers.

Sequential circuits. Explicit functional description. Latches and flip-flops. Registers and shift registers. Counters. Memories-introduction to SRAM & DRAM, Cache memory.

Introduction to Finite state machines (FSM)- Implement state machines for real life applications.

Textbooks:

1. Digital Systems, Principles and Applications by Ronald J. Tocci, Neal S Widmer, Gregory L. Moss, Pearson Publication.
2. Digital Logic and Computer Design Fundamental by Morris Mano, Pearson Publication, 5th Edition.

Course Title and Code: Critical Thinking and Storytelling (CC1102)	
Hours per Week	**L-T-P: 2-0-1**
Credits	**2**
Students who can take	B.Tech Semester- II
Prerequisites	None
Weightage	Theory 40% Practical 60%

Course Objectives: The modern world offers confounding opinions and choices that need to be navigated judiciously. This course explores frameworks and processes to critically examine narratives, reconstruct them, and craft well-reasoned stories that can be told using impactful communication.

Learning Outcomes:

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

1 Formulate intelligent questions to investigate.

2 Evaluate information and argument for correctness, consistency, relevance, and validity.

3 Compose well-structured and well-reasoned arguments.

4 Articulate and evaluate the impact of narratives.

5 Distinguish between facts, assumptions, and opinion.

Course Syllabus (Theory)

UNIT I: Introduction to Critical Thinking- Definitions of Critical Thinking, its applications and the methods to think critically. Paul & Elder model will be used.

UNIT II: Importance of questioning- The key to critical thinking is the ability to formulate intelligent questions. Students will be able to create, improve and prioritize their questions. They will be able to use different types of question by using Bloom's taxonomy to understand the root of any situation, problem or subject.

UNIT III: Examine data critically- Students will be able to filter information, separate fact from opinion, identify cognitive biases and become aware of the ladder of inference. They will also be taught to conduct responsible research and basics of bibliography and citation.

UNIT IV: Construct and reconstruct argument- Students will be taught to construct arguments with sound reasoning. They will be able to support their claims and opinions with compelling data and facts, and present well-informed arguments. Evaluate argument using logical fallacies.

UNIT V: Building a compelling narrative- Stories that we create and narrate influence how we see ourselves and our association with others. The students will be able to observe, think, create and narrate their stories in an effective manner.

Reference:

Critical Thinking: An Introduction
Alec Fisher - Cambridge University Press - 2011

Critical Thinking: Its Definition and Assessment
Alec Fisher-Michael Scriven - Centre for Research in Critical Thinking - 1997

Art of Thinking Clearly
Rolf Dobelli - Harper Collins – 2014

Critical Thinking Skills: Developing Effective Analysis and Argument
Stella Cottrell - Palgrave Macmillan – 2017

Thinking, Fast and Slow
Daniel Kahneman - Farrar, Straus and Giroux – 2015

Chimamanda Ngozi Adichie: The danger of a single story | TED - YouTube. (n.d.). Retrieved 10 January 2023, from https://www.youtube.com/watch?v=D9Ihs241zeg&list=PLCttQajkONuymB2BTPLW5ndPn9nAt2QRC&index=10&t=13s&ab_channel=TED
Edward Said and Orientalism: A Simple Explanation—YouTube. (n.d.). Retrieved 10 January 2023, from https://www.youtube.com/watch?v=RfeAxw502Hs&list=PLCttQajkONuymB2BTPLW5ndPn9nAt2QRC&index=13&t=50s&ab_channel=UniversityQuickCourse
Edward Said—Framed: The Politics of Stereotypes in News—YouTube. (n.d.). Retrieved 10 January 2023, from https://www.youtube.com/watch?v=4QYrAqrpshw&list=PLCttQajkONuymB2BTPLW5ndPn9nAt2QRC&index=12&ab_channel=AlJazeeraEnglish
Noam Chomsky—Manufacturing Consent—YouTube. (n.d.). Retrieved 10 January 2023, from https://www.youtube.com/watch?v=tTBWfkE7BXU&list=PLCttQajkONuymB2BTPLW5ndPn9nAt2QRC&index=15&t=46s
Noam Chomsky—The 5 Filters of the Mass Media Machine—YouTube. (n.d.). Retrieved 10 January 2023, from https://www.youtube.com/watch?v=34LGPIXvU5M&list=PLCttQajkONuymB2BTPLW5ndPn9nAt2QRC&index=14&t=109s&ab_channel=AlJazeeraEnglish

Course Title and Code: Data Structures and Algorithms (CS1131)	
Hours per Week	**L-T-P: 3-0-2**
Credits	4
Students who can take	B.Tech. Semester III (CSE+CCE)
Prerequisites	Programming II
Weightage	Theory 70% Lab 30%

Course Objectives: In this course, students will explore the concepts of algorithms and data structures. This course aims to develop a good understanding of Data Structures concepts and its implementation to solve various computational problems using C and C++. Main topics are Complexity analysis (time & space), Recursion, Linear Data Structures (Arrays, Queue, Stack, Linked list), Searching, Sorting, Non-linear data structures (Trees, Graphs), Indexing and Hashing.

Learning Outcomes:

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

1. Have a good understanding of different data structures stacks, queues, lists, trees and graphs
2. Learn the implementation of above data structures in C and C++ by writing programs for performing the basic operations like insertion, deletion, searching, traversal, etc.
3. Develop skills to apply appropriate data structures in problem solving.
4. Analyse the algorithms in terms of asymptotic time and space complexity.
5. Implement and compare various searching and sorting algorithms.
6. Understand recursion and its implementation.

Course Syllabus (Theory)

Unit-1: Writing algorithms for simple problems, Understanding Analysis of time and space complexity, Big O notation, Evaluating complexity for simple problems.

Unit 2: Types of Data Structures: Linear & Non-Linear, Concepts of different linear structures: Arrays, Stacks, Queues, Linked list, Understanding Operations, Implementation and Applications of Stacks, Queues, Linked list. Evaluation of expression in infix, postfix & prefix forms using stack, Queues: Circular Queues: Operations and Applications, De-queue and Priority queue, Sparse matrix, Recursion.

Unit -3: Sorting and searching algorithms. Linear and binary search, insertion sort, selection sort, bubble sort, merge sort, quick sort. Complexity Analysis of different sorting and searching algorithms.

Unit-4: Non-linear Data Structures: Trees definition, characteristics, concept of child, sibling, parent child relationship etc., binary tree: its applications, insertion, deletion and traversal of binary trees, constructing binary tree from traversal results. Array-based implementation, Concept of Heap, Priority queue implementation using heap.

Binary Search Tree: Concept of BST, insertion into and deletion from BST, Height balanced tree: Introduction to AVL Tree, Application of trees for representation of sets.

Introduction to Multiway search trees.

Unit-5 Graphs: Directed and undirected graphs, representation of graphs using adjacency matrix and list, Depth first and breadth first traversal of graphs. Topological sorting. Hashing,

Text Books:

T1 Tenenbaum, A. M., Langsam, Y., & Augenstein, M. J. (1996). Data Structures using C and C++. Prentice-Hall.

T2. Seymour, L. (2020). Data Structures With C McGraw: Hill Book Company..

T4. “Fundamental of Data Structure” (Schaums Series) Tata-McGraw-Hill.

Reference Books:

R1. ReemaThareja, “Data structures using C”, Oxford University Press, Second Edition, 2014.
R2. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein.
R3. Alfred V. Aho, Jeffrey D. Ullman, John E. Hop croft, Data Structures and Algorithms. Pearson Education, 2012.

Reference Online Material

Data Structure and Algorithms NPTEL
https://nptel.ac.in/courses/106/102/106102064/
https://nptel.ac.in/courses/106/106/106106127/

Coursera
Data Structures and Algorithms Specialization
https://www.coursera.org/specializations/data-structures-algorithms
Data Structures and Performance
https://www.coursera.org/learn/data-structures-optimizing-performance
Ordered Data Structures
https://www.coursera.org/learn/cs-fundamentals-2

GeekforGeeks
https://www.geeksforgeeks.org/data-structures/

Course Title and Code: Computer Organization and Architecture (CS1134)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. CSE III Semester
Prerequisite	Digital circuit and systems
Weightage	Theory -65%, Practical and Assignments – 35%

Course Objectives: To study the basic organization and architecture of digital computers (CPU, memory, I/O, software). Such knowledge leads to a better understanding and utilization of digital computers and can be used in the design and application of computer systems or as the foundation for more advanced computer-related studies.

Learning Outcomes:

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

1. Draw the functional block diagram of the single bus architecture of a computer and describe the function of the instruction execution cycle, RTL interpretation of instructions, addressing modes, and instruction set.
2. Summarize and compare different computer systems.
3. Categorize different types of computers based on Instruction set Architecture.
4. Develop assembly language programs for multiplication, division, and I/O interface using 8086.
5. Given a CPU organization and instruction, design a memory module and analyze its operation by interfacing with the CPU.
6. Write a flowchart for Concurrent access to memory and cache coherency in Parallel Processors and describe the process.
7. Given a CPU organization, assess its performance, and apply design techniques to enhance performance using pipelining, parallelism, and RISC methodology.
8. Analyze the performance of pipeline and cache-based systems.

Course Syllabus (Theory):

Unit I: BASIC STRUCTURE OF COMPUTERS: Review of Digital Logic and Systems, Functional units, Von Neuman and Harvard Architecture Basic operational concepts, Bus structures, PCI, Multiple bus organization, Performance, and metrics,

Unit II: BASIC PROCESSING UNIT: Fundamental concepts, Execution of a complete instruction, The Arithmetic and Logic Unit (ALU), Number Systems, Fixed point representation, and Arithmetic, Floating Point Representation and Arithmetic, Hardwired control, Micro programmed control.

Unit III: INSTRUCTION SETS: Characteristics and functions, x86 Architecture, Instruction set architecture, Addressing modes and formats, RISC and CISC.

Unit IV: PIPELINING: Basic concepts, Data hazards, Instruction hazards, Influence on instruction sets, Data path, and control path, Performance considerations, Exception handling.

Unit V: MEMORY SYSTEM: Basic concepts, Memory Hierarchy, Semiconductor RAM, ROM, Speed, Size and cost, Cache memories, Improving cache performance, Virtual memory, Memory management requirements, Associative memories, and Secondary storage devices.

Unit VI: I/O ORGANIZATION: Accessing I/O devices, Programmed Input/Output, Interrupts, Direct Memory Access, I/O devices, and processors.

Unit VII: PARALLEL PROCESSING: The use of multiple processors, Symmetric Multiprocessors, Cache coherence, UMA, and NUMA.

Text Books:

- Mano, M. Morris. "Computer system architecture, 1993." Prentice Hall 3: 299.
- Patterson, David A., and John L. Hennessy. Computer Organization and Design MIPS Edition: The Hardware/Software Interface. Newnes, 2013.

Reference Books:

- Hayes, John P. Computer architecture and organization. McGraw-Hill, Inc., 2002.
- Heuring, Vincent P., Harry Frederick Jordan, and Miles Murdocca. Computer systems design and architecture. Addison-Wesley, 1997.
- Kai Hwang & Naresh Jotwani - Advanced Computer Architecture: Parallelism, Scalability, Programmability, Tata McGraw Hill, 2003

Course Title and Code: Database Management Systems (CS1133)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. III Sem
Prerequisites	None
Weightage	Theory 55% Lab 45%

Course Objectives: This course aims to introduce the concepts of databases and database management systems. At the end of the course, students will have a good understanding of relational data model, relational query languages, database processing, SQL, transaction management and database recovery.

Learning Outcomes:

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

1. Understand data and relational database concepts
2. Model high level system requirements using conceptual modelling (ER)
3. Develop relational and physical database design
4. Compose queries using SQL
5. Apply Transactions to a real application
6. Understand algorithms and techniques to recover from data loss

Course Syllabus (Theory):

Unit 1: Introductory Concepts of Data - Transactional, Analytical and Master Data, Structured, Unstructured and Semi Structured Data, Data file and Database - Data File systems versus Database, Database system concepts and architecture along with logical database and physical database concepts.

Unit 2: Conceptual Database Design - High-level conceptual modeling, ER Modeling concepts, ER Diagrams, Cardinality constraints, Higher-order relationships: Aggregate and Specialization, ER to relational mapping.

Unit 3: Querying Relational Data: Structured Query Language - data definition language, integrity constraints, data manipulation language, data control language. Simple queries, queries using Joins, using aggregate functions. Joins - inner, left outer, right outer, full outer and cross joins. Updates and updates with joins, Relational Algebra and Relational Calculus.

Unit 4: Relational Schema Refinement and Normal Forms - Functional dependencies, Armstrong Axioms, Concept of Closure: Attribute and FD, Normal forms upto Boyce-Codd Normal Forms

Unit 5: Transaction Processing and Concurrency Control - ACID properties, Transaction states, Concurrency issues, Conflict-serializability, View serializability, Concurrency control: Locking, Time stamp ordering, Cascading rollbacks, Deadlocks and starvation, Physical Database Design, Database Recovery Techniques.

Text Books:

1. Henry F. Korth, Abraham Silberschatz, S. Sudarshan, Database System Concepts, 6th edtion, Tata McGraw Hill 2013, ISBN-10: 9332901384)
2. R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, 6th edition, Pearson Education
3. R. Ramakrishnan and J. Gehrke, Database Management Systems, 3rd edition, McGraw Hill, 2014, ISBN-10: 9339213114.

Reference Online Course:

1. Introduction to Databases by Meta – Coursera: Introduction to Databases Course (Meta) | Coursera
2. The Structured Query Language (SQL) – Coursera: The Structured Query Language (SQL) | Coursera

Course Title and Code: Probability and Statistics (AS2170)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech III Sem
Pre-requisite	None
Weightage	Theory – 70%, Lab – 30%

Course Objectives: This course introduces computational analysis of data based on fundamental concepts of statistics. The course will include utilizing Python in a hands-on way to solve various problems related to statistical data analysis.

Learning Outcomes:

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

1. develop programs for analyzing and interpreting complex situations in various domains including sustainable development using statistical methods.
2. summarize and visualize different datasets.
3. analyze and interpret different datasets using discrete and continuous probability distributions and apply the same for problem-solving, e.g., Goodness of Fit.
4. formulate and validate hypotheses with reference to different datasets.
5. apply correlation, regression, and least square method, for modeling, analysis, interpretation, and forecasting.

Syllabus

Descriptive Statistics

Measures of central tendency, measures of dispersion, skewness and kurtosis, frequency distributions, graphical representation, measures of locations, and variability.

Probability Theory

Introduction to probability, conditional probability, Bayes' theorem, Discrete and continuous random variables, Probability mass and density functions, Probability distributions: Binomial, Poisson, Uniform, Normal, Exponential

Sampling Distributions

Sampling, Types of sampling, sampling errors, sampling distribution of means, variance, and proportions for the normal population, The Central Limit Theorem, Chi-Square, t, and F distributions, Point and interval estimation.

Test of Hypothesis

Null and alternative hypotheses, types of errors, p-values, Parametric test of hypothesis based on mean, variance, and proportion, goodness-of-fit tests, One-way analysis of variance (ANOVA), correlation, and regression analysis.

Text and Reference Books

1. Richard A. Johnson, Miller and Freund's Probability and Statistics for Engineers, PHI.
2. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley & Sons, Inc., 3rd Edition (2004).
3. Meyer, P. L., Introductory Probability and Statistical Applications, Oxford & IBH (1970).
4. Baisnab, A. P. and Jas, Manoranjan, Elements of Probability and Statistics, Tata McGraw Hill, 13th Reprint (2006).
5. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, New Delhi (2010).

Course Title and Code: Essentials of Management & Business (LS1108)	
Hours per Week	**L-T-P: 3-0-0**
Credits	**3**
Students who can take	B. Tech III Sem
Prerequisite	None
Weightage	Theory 60% Practical 40%

Course Objectives: This course explores the basic concepts, processes and practices of management in managing business organizations. It focuses on providing understanding of management and its application in all types of businesses. It also helps students to understand how organizations develop and maintain competitive advantage within a changing business environment. The course will involve more of interactive sessions and open discussions within the class. The students are expected to come prepared to the class and actively participate in classroom discussions

Learning Outcomes:

On successful completion of this course, the students should be able to

1. Appreciate multiple approaches to developing management as a field of study.
2. Comprehend the importance of managerial role in various functional areas for organizational performance
3. Identify the forces in business environment impacting organizations and its management practices.
4. Evaluate the relevance of management principles in alternative organizational context
5. Discuss current concerns in management theory and practices

Topics:

1. Managers and Management
2. Management Functions
3. Business Purpose: Vision, Mission, Goals and objectives
4. Understanding Business Organizations as Systems
5. Environment, Social and Corporate Governance
6. Economics and Business

Readings:

1. Bhat, A. and Kumar, A (2010). ***Management Principles, Processes and Practices***. New Delhi: Oxford University Press
2. Koontz, H. and Weihrich, H. (Latest Edition). ***Essentials of Management: An International Perspective, 8e.*** New Delhi: Tata McGraw Hill.
3. Tripathy, P.C. and Reddy, P. N. (2012). **Principles of Management.** McGraw Hill, New Delhi.
4. T. R. Jain (Latest Edition). Economics for Engineers. New Delhi: V K Publications.

MOOC

1. Fundamentals of Management by the University of California, Irvine (Coursera): https://www.coursera.org/learn/fundamentals-of-management?#about

Course Title and Code: Perspectives on Contemporary Issues (CC1103)	
Hours per Week	**L-T-P: 2-0-1**
Credits	**2**
Students who can take	BBA/ Bdes/ B.Tech Sem III
Prerequisites	None
Weightage	Theory 60%, Practical 40%

Course Objectives-

In an era of globalization, there is an increasing need for the youth to be able to empathize with others, value diverse perspectives and cultures and understand how events around the world are intertwined. Global issues revolve around social, economic and environmental factors which ultimately add to the interconnectedness of countries. In this course, students will employ key critical thinking concepts to analyze contemporary issues from multiple perspectives. They will explore the impact at micro and macro levels.

Learning Outcomes :

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

1 Identify different perspectives objectively.

2 Explain interconnectedness of the issues and their impact at micro and macro levels.

3 Recognize their own beliefs, biases, claims and assumptions.

4 Evaluate sources, argue and defend effectively.

Course Syllabus (Theory):

Research, analysis & evaluation of a topic from local, national and global perspectives.

- **Globalization**

With increasing development throughout the world, the focus of this theme will be on the impact of adopting policy of neoliberalism globally. Changes in India after implementation of new economic policy of 1991.

- **Poverty and Inequality**

What do you mean by wealth & equality? Is it enough to ascribe monetary values to human lives? Who has benefited from an increased access to resources, labour & capital due to globalisation? Which groups are historically marginalised & suffer from unequal access to opportunities

- **Social justice and human rights**

An understanding of the impact of inequality and discrimination, the importance of standing up for our own rights and our responsibility to respect the rights of others.

- **Climate Change and Sustainability**

Understanding the magnitude of the issue, its impact and future challenges. How we can meet our current needs without diminishing the quality of the environment or reducing the capacity of future generations to meet their own needs.

- **Technology**

Impact of unprecedented technological growth, challenges and opportunities. Is technocracy a boon or a bane?

References for reading:

1. Held, D. and McGrew, A., 2016. *The Global Transformations Reader*. 2nd ed. Cambridge: Polity Press.

2. Schmelzer, M., Vetter, A. and Vansintjan, A., 2022. *The Future is Degrowth*. London: Verso.

3. Harvey, D., 2020. A Brief History of Neoliberalism. In: F. Lechner and J. Boli, ed., *The Globalization Reader*, 6th ed. Wiley.

4. Kolbert, E. (2015). The Sixth Extinction: An unnatural History.

5. https://www.downtoearth.org.in/blog/governance/mass-poverty-is-back-in-india-76348

6. https://geographyandyou.com/indias-poverty-line-changing-perspectives/

Course Title and Code: **Design and Analysis of Algorithms (CS1105)**	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech- IV Sem
Prerequisites	Data Structures and Algorithms
Weightage	Theory 60 % Practical 40 %

Course Objectives:

This course introduces an understanding of the design and analysis of algorithms. The course aims to develop familiarity with specific algorithms of significance and data structures. It further incorporates the ability to analyze performance and compute complexity of algorithms at best and worst case scenario. It will equip the students to apply important algorithmic design paradigms and methods to develop efficient algorithms for resolving computation and design related problems.

Learning Outcomes:

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

1. Analyze the complexity of different algorithms using asymptotic analysis.
2. Analyze and select an appropriate data structure for a computing problem.
3. Differentiate between different algorithm designs technique: Divide and Conquer Technique, Greedy, Backtracking, and Dynamic Programming. Also, recognize when an algorithmic design situation calls for using these.
4. Develop algorithms and programs using techniques like Divide and Conquer, Backtracking technique and Dynamic Programming to solve various computing problems
5. Develop energy-efficient algorithms and programs using Greedy approach to solve various computing problems,
6. Apply Query optimization algorithms using Greedy and Dynamic programming approaches.
7. Apply various search-based problem-solving methods , Heuristics, and Informed search .
8. Evaluate and apply appropriate energy efficient algorithmic design technique for solving complex computing problem.
9. Explain the ways to analyze randomized algorithms (expected running time, probability of error).
10. Differentiate between P, NP, NP-Complete, and NP-Hard problems.

Course Syllabus (Theory):

UNIT I: Introduction: Algorithms, Analyzing algorithms, Complexity of algorithms, Growth of functions, Performance measurements, Types of approaches.

UNIT II: Selection sort, Bubble sort, Insertion Sort, Shell sort, Quick sort, Merge sort, Heap sort, sorting in linear time: Radix sort, Counting Sort, Comparison of sorting algorithms, Divide and Conquer with examples such as Sorting, Matrix Multiplication, Convex hull and Searching

UNIT III: Greedy methods with examples such as Optimal Reliability Allocation, Knapsack, Minimum Spanning trees – Prim's and Kruskal's algorithms, Single-source shortest paths - Dijkstra's and Bellman-Ford algorithms.

UNIT IV: Dynamic programming with examples such as Knapsack, all pair shortest paths – Warshal's and Floyd's algorithms, Resource allocation problem, Backtracking, Branch and Bound with examples such as Travelling Salesman Problem.

UNIT V: Selected Topics: String Matching, Huffman Coding, Theory of NP-completeness, Approximation

algorithms and Randomized algorithms.

Text Book(s)

1. Thomas H. Coreman, Charles E. Leiserson and Ronald L. Rivest, “Introduction to Algorithms”, Prentice Hall of India. 2002.
2. S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani, “Algorithms”, McGraw-Hill Education, 2006.

Reference Book(s)

1. RCT Lee, SS Tseng, RC Chang and YT Tsai. Introduction to the Design and Analysis of Algorithms. Mc Graw Hill, 2005.
2. E. Horowitz & S Sahni. Fundamentals of Computer Algorithms. 1984
3. Berman, Paul. Algorithms. Cengage Learning. 2002
4. Aho, Hopcraft, Ullman, The Design and Analysis of Computer Algorithms. Pearson Education, 2008.

Reference Online Material

NPTEL Swayam Course:

1. https://nptel.ac.in/courses/106/106/106106127/
2. https://nptel.ac.in/courses/106/102/106102064/
3. http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html

Course Title and Code: Machine Learning (CS1138)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. IV Sem
Prerequisites	Programming-I, Linear Algebra and Differential Equations, Probability and Statistics
Weightage	Theory 75%, Lab 25%

Course Objectives: This course introduces the fundamental concepts of machine learning and statistical pattern recognition. It will cover aspects of supervised and unsupervised learning. To be specific, linear regression, logistic regression, decision trees, random forests, SVM, clustering, PCA, KNN, etc will be taken up in detail. The course will also thoroughly cover gradient descent, its variants and regularization techniques. Towards the end, we will also introduce basics of neural networks and deep learning.

Learning Outcomes:

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

1. Judge whether a problem should be solved using machine learning.
2. Apply various techniques that are well suited according to the problem.
3. Apply regularization techniques to solve the problem of high bias and high variance.
4. Design machine learning models that are suited to solve a particular problem.
5. Build programs that implement the theoretical concepts learned in this course.

Course Syllabus (Theory):

Unit I: Motivation, learning paradigms, Applications of ML. Representations (features) extracted from data. Linear transformations, matrix vector operations in the context of data and its representations. Problem formulation: classification and regression. Probability distributions in the context of data, Prior probabilities and Bayes Rule. Introduce paradigms of learning: supervised and unsupervised.

Unit II: PCA and Dimensionality Reduction, Nearest Neighbours and KNN, Linear Regression, Decision Tree Classifiers, Generalization and overfitting. Training, Dataset partitioning and preprocessing. Model evaluation metrics, ROC curve.

Unit III: Ensembling and Random Forest, Linear SVM, K-Means, Logistic Regression, Naive Bayes.

Unit IV: Role of Loss functions, optimization, gradient descent and perceptron learning, MLP, Backpropagation, neural network classification and regression, regularization, early stopping, Introduction to Deep Learning and CNNs.

Reference Books:

There is no particular book for the course. However, they serve as good references:

1. Tom Mitchell, *Machine Learning,* McGraw Hill, 1997.
2. Goodfellow et. al, Deep Learning, MIT Press, 2016.

Reference Online Course:

CS229: Machine Learning, Stanford University

Online available at: https://cs229.stanford.edu/

Coursera Specialization on Machine Learning

Online available at: https://www.coursera.org/specializations/machine-learning-introduction

Course Title and Code: Operating Systems (CS1108)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech-CSE, Sem IV
Prerequisites	None
Weightage	Theory 70%, Lab 30%

Course Objectives: The main aim of this course is to describe the structure and functioning of operating system. At the end of the course, the students will be well aware of the concepts of process management, memory management, file management and I/O hardware.

Learning Outcomes:

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

1 Use basic LINUX commands

2 Understand the structure of OS and its interface with hardware

3 Differentiate between different types of operating systems

4 Implement and assess the performance of different types of scheduling algorithms.

5 Have a good knowledge of process synchronization and Inter process communication, deadlock

6 Analyze and implement various disk-scheduling algorithms

Course Syllabus (Theory):

Unit 1: Introduction to OS – Concept of operating system, Generations of Operating systems, Types of operating system, Services, System calls, Structure of an OS-Layered, Microkernels, Virtual Machines, Case study on Windows and LINUX operating system

Unit 2: Process Management - Concept of process, Process states, Process State transitions, Process Control Block (PCB), Context switching, **Process scheduling:** Foundation and Scheduling objectives, Types of Schedulers. **Scheduling criteria:** CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time. Scheduling algorithms: Pre-emptive and Non-preemptive, FCFS, SJF, Priority, R-R scheduling, Multilevel queue scheduling. **Inter process communication:** Critical section, Race condition, semaphores, monitors, message passing, **Classical IPC Problems:** Readers-Writer Problem, Dinning Philosopher Problem etc. Deadlock: Shared resources, resource allocation and scheduling, resource graph models, deadlock prevention, deadlock avoidance, deadlock detection, deadlock recovery algorithms.

Unit 3: Memory Management - Memory management schemes, Contiguous/Non-contiguous memory allocation, storage management, paging, page table structure, segmentation, segmentation with paging, virtual memory, demand paging, page fault, Page replacement algorithms.

Unit 4: File Management - File concept, types and structures, attributes of a file, operations performed on file, File organization and access method, file allocation methods, directory structure, file directories, directory implementation.

Unit 5: I/O Hardware - I/O devices, I/O hardware, device driver, Kernel I/O sub-system, Interrupt. **Disk scheduling:** Disk Structure, FCFS, SSTF, SCAN, LOOK, C-SCAN, C-LOOK.

Text Books:

1. Silberschatz, Peter B. Galvin and G. Gagne, Operating System Concepts, Wiley, 2012.
2. W. Stallings. Operating Systems: Internals and design Principles, Pearson Education, 2014.
3. M. G. Venkateshmurthy. Introduction to Unix & Shell Programming, Pearson Education, 2009.

Reference Books:

1. Andrew S. Tanenbaum and Herbert Bos. Modern Operating Systems, Pearson Education, 2014.
2. Thomas Anderson and Michael Dahlin. Operating Systems: Principles and Practice, Recursive Books, 2014.

3. Richard Blum, Christine Bresnahan. Linux Command Line and Shell Scripting Bible, Wiley, 2015.

Reference Online Course:

1. https://nptel.ac.in/courses/106106144
2. https://nptel.ac.in/courses/106105214

Course Title and Code: Managing Business Functions (LS1109)	
Hours per Week	**L-T-P: 3-0-0**
Credits	**3**
Students who can take	B. Tech IV Sem
Prerequisite	None
Weightage	Theory 60% Practical 40%

Course Objectives: This course provides an overview of important functional verticals of any business organizations which work in integrated manner to ensure business performance The course will provide an in-depth understanding of how management principles gets reflected in its practices and processes. The students will gain holistic understanding about how businesses run and relevance of its each functional departments in contributing towards its goal achievement. The students would discuss and diagnose real case scenarios to gain clarity about business function, identify problems and recommend practical solutions.

Learning Outcomes:

On successful completion of this course, the students should be able to

1. Appreciate multiple functional verticals of business organizations.
2. Comprehend the connectedness of functional verticals in building successful business strategy.
3. Evaluate and analyse real business problems through an accurate synthesis of the information.
4. Identify the forces in business environment impacting organizations and its management practices.
5. Apply managerial knowledge, method and research techniques to identify and solve management problems

Topics :

1. Introduction to core business functional areas and its integration
2. Excelling Through People: Overview of HRM, Job Design, Recruitment and Selection, Training and Development
3. Accounting and Financial Analysis: Understanding Accounting as the Language of Business, Key Financial Statement, Analysis of Financial statements, Ratio Analysis, Goals and Functions of Finance.
4. Operations Management: Introduction to Operations Management, Operations Strategy, Quality Management, Supply Chain Management.
5. Creating and delivering Customer value: Defining Marketing and the Marketing Process, Marketing Strategy and Developing an Integrated Marketing Mix, Understanding Consumer Markets and Consumer Buying Behavior.

Readings:

1. Dessler, G. (2018) – Fundamentals of Human Resource Management, 4e, India, Pearson Publications.
2. Rao VSP (Latest Edition)– Human Resource Management, Text and Cases,Excel Book, New Delhi
3. Kotler, P., Armstrong, G. and Agnihotri, P. (2022). Principles of Marketing. New Delhi: Pearson Education.
4. Ramaswamy, V. S., & Namakumari, S. (2018). Marketing Management: Global Perspective, Indian Context. New Delhi: SAGE Publications India Pvt. Ltd.
5. Ramachandran N & Kakani K.Ram.(2017). How to Read a Balance Sheet,2/e. New Dehi: Mc Graw Hill Publications.
6. Mott Graham. (2008). Accounting for Non-Accountants: A Manual for Managers and Students. Kogan Publication.
7. Goyal, V.K. & Goyal, Ruchi. (2016). Financial Accounting, 4/e, New Delhi: PHI Learning Pvt. Ltd.[ISBN.-978-81-203-4626-0]

8. Russell, R. S., & Taylor-Iii, B. W. (2008). Operations management along the supply chain. John Wiley & Sons.
9. Heizer, J., Render, B., & Munson, C. (2017). Operations management. Pearson Education Limited.

MOOC

- Operations Management: Analysis and Improvement Methods by University of Illinois (Coursera):
- https://www.coursera.org/programs/j-k-lakshmipat-university-on-coursera-kzogk?collectionId=&productId=schck0kuEealsQ4S5bCf-Q&productType=course&showMiniModal=true
- Marketing Management-I: University of Illinois at Urbana-Champaign: 24 hourshttps://www.my-mooc.com/en/mooc/marketing-management-i/
- Understanding Financial Statements: Company Performance by University of Illinois (Coursera): https://www.coursera.org/learn/income-statement?action=enroll#modules ·
- HR for Non HR Managers: https://onlinecourses.swayam2.ac.in/cec23_mg23/preview? (Swayam)

Course Title and Code: Communication and Identity (CC1104)	
Hours per Week	**L-T-P: 2-0-1**
Credits	**2**
Students who can take	B.Tech/BCA/BBA/B.Des Semester- IV
Prerequisite	None
Weightage	Theory 40%, Practical 60%
Course Objectives: This course enables students to explore their identities to mark their distinctive presence in professional spaces. It intends to help them gain an understanding of the basic purpose, benefits, and responsibilities of self-presence, and to begin the process of defining their values, strengths, and goals, which helps them enhancing their employability skills through exposing themselves through various activities.	
Learning Outcomes: On successful completion of this course, the students should be able to: 1. Analyze their personal identities by identifying their personal attributes, values, strengths and vision statement. 2. Articulate their personal statement and use it to craft an influential pitch. 3. Express themselves professionally on various social media platforms. 4. Write a well-structured professional business document.	

Course Topics

Module(s)	Topics to be covered
Identifying Self	Discovering Identities: Words That Describe Me, Your Personal Identity, A Portrait of Yourself, Personal Identity Wheel, Self-Awareness from five aspects that influence our identity - Personal Attributes, Value and Principles, Emotional Awareness, Tendencies and Habit, Needs Assessment.
	Personal Branding: Meaning, Importance and how to create and use it; Identify, Build and Market your brand story.
Persuasive Communication	Personal Brand Statement, Resume, Cover Letter and The Elevator Pitch, Presence in Group Discussion and Personal Interviews
	Online Brand Communications- Creating an online presence for professional branding on social media platforms (LinkedIn, Facebook, Instagram, etc)
	Writing a well-structured and effective business documents (Agenda, Minutes of the meetings (MoM) Emails, Executive Summary)

Referred MOOCs –

Course Name- Introduction to Personal Branding
Course duration - approx. 7 hours
Offered by University of Virginia
https://www.coursera.org/learn/personal-branding

Course Name- Digital Footprint (If I Googled you, what would I find?)
Course duration - approx. 9 hours
Offered by The University of Edinburgh
https://www.coursera.org/learn/digital-footprint

Course Name- High Impact Business Writing
Course duration - approx. 7 hours
Offered by University of California, Irvine
https://www.coursera.org/learn/business-writing

Referred Books -

- Garner, B. A. (2012). HBR Guide to Better Business Writing. United States: Harvard Business Review Press.
- Westfall, C. (2012). The New Elevator Pitch. United States: Marie Street Press.
- Arruda, W., Dixson, K. (2010). Career Distinction: Stand Out by Building Your Brand. Germany: Wiley.
- Hedges, K. (2017). The Power of Presence: Unlock Your Potential to Influence and Engage Others. United States: AMACOM.
- Lacy, K., Deckers, E. (2012). Branding Yourself: How to Use Social Media to Invent Or Reinvent Yourself. United Kingdom: Pearson Education.

Course Title and Code: Practice School – I (PS-I), PS1101	
Total Duration	**45 Days**
Credits	**04**
Students who can take	B.Tech Semester-V
Prerequisite	None
Weightage	Practical 100%

Course Objectives:

The purpose of Practice School-I is to give an opportunity to re-understand their theoretical knowledge in the context of real life situations.

Learning Outcomes:

After course completion, the student will be able to:

1 Identify skills and capabilities that interconnect effectively with the needs of industry.

2 Demonstrate problem solving skills in the context of some real life situation.

3 Reflect and evaluate on future employment opportunities.

Course Title and Code: Discrete Mathematics (CS1141)	
Hours per Week	**L-T-P 3-1-0**
Credits	**4**
Students who can take	B.Tech V Sem
Prerequisite	None
Weightage	Theory 100 %
Course Objectives: This course introduces the students to basic concepts of mathematical logic for analyzing propositions, use sets for solving applied problems, work with relations and investigate their properties, and introduce basic concept of graphs.	
Learning Outcomes: On successful completion of this course, the students should be able to: 1. Use mathematical terminology and notations to understand the examples in Computer Science. 2. Solve real world problems by applying the knowledge of mathematics 3. Formulate mathematical claims and be able to construct counter examples 4. Learn how to divide a problem, or a proof, into smaller cases. 5. Identify algebraic structures in Computer Science	

Course Syllabus (Theory):

Unit 1: Set, Relations and Functions - Basic operations on sets, Cartesian products, disjoint union (sum), and power sets. Different types of relations, their compositions and inverses. Different types of functions, their compositions and inverses.

Unit 2: Propositional Logic - Syntax and semantics, proof systems, satisfiability, validity, soundness, completeness, deduction theorem, etc. Decision problems of propositional logic. Introduction to first order logic and first order theory.

Unit 3: Partially Ordered Sets - Complete partial ordering, chain, lattice, complete, distributive, modular and complemented lattices. Boolean and pseudo Boolean lattices.

Unit 4: Algebraic Structures - Algebraic structures with one binary operation – semigroup, monoid and group. Cosets, Lagrange's theorem, normal subgroup, homomorphic subgroup. Congruence relation and quotient structures. Error correcting code. Algebraic structures with two binary operations- ring, integral domain, and field. Boolean algebra and Boolean ring (Definitions and simple examples only).

Unit 5: Introduction to Counting - Basic counting techniques – inclusion and exclusion, pigeon-hole principle, permutation, combination, summations. Introduction to recurrence relation and generating functions.

Unit 6: Introduction to Graphs - Graphs and their basic properties – degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, trees.

Text Books:

1. C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.
2. R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.
3. R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison Wesley, 1994.
4. K. H. Rosen, Discrete Mathematics and its Applications, 6th Ed., Tata McGraw-Hill, 2007.
5. J. L. Hein, Discrete Structures, Logic, and Computability, 3rd Ed., Jones and Bartlett, 2010.
6. N. Deo, Graph Theory, Prentice Hall of India, 1974.
7. S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999.
8. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997

Reference Online Course:

1.https://nptel.ac.in/courses/106108227

2.https://nptel.ac.in/courses/106106183

Course Title and Code: Artificial Intelligence	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	
Prerequisites	**Data Structures**
Evaluation	

Course Objective: This course discusses the origin and evolution of the field of Artificial Intelligence, failures, successful applications and philosophical foundations. This course will cover state of the art topics in AI as covered in various universities throughout the world. It will cover the basics of uninformed search, A* search and heuristics, constraint satisfaction problems, minimax, expectimax, probabilistic decision making using Bayes Net, Reinforcement learning.

Learning Outcome:

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

1. Identify problems that are amenable to solution by AI methods.
2. Reason about the state-space search algorithm to use under different problem specific conditions.
3. Implement two player games like TicTacToe.
4. Understand use of Markov decision process and reinforcement learning for real-life applications.
5. Design and code solutions to a wide variety of artificial intelligence problems where the machine can learn from the world and act accordingly.

Course Contents:

Unit I: Introduction to Artificial Intelligence, History and Philosophy of AI, Intelligent Agents, Classical AI problems, Problem Spaces and Problem Analysis.

Unit II: Solving problems by Searching, Uninformed search (DFS/BFS), Informed Search/Heuristics based search techniques, Generate and test, hill climbing, best first search. Adversarial Search.

Unit III: Graph Pruning, Min-Max Algorithm, Alpha-Beta Pruning. Game Trees. Constraint Satisfaction Problems.

Unit IV: Markov Decision Processes. Introduction to Reinforcement Learning.

Unit V: Knowledge Reasoning and Planning, Logical Agents, First-Order Logic, Bayes Nets, Representation, Independence, Inference, Sampling.

Text Book:

There is no particular book for the course. However, the following serve as a good reference:

2. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2022.

Reference Online Course:

CS188 Fall 2018 UC Berkley: Artificial Intelligence.
Online available at: https://inst.eecs.berkeley.edu/~cs188/fa18/

Course Title and Code: Deep Learning	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech V Sem
Prerequisites: Machine Learning	
Course Objective: This course covers the most successful form of artificial intelligence, deep learning. We will be covering linear regression, logistic regression, deep neural networks, convolutional and recurrent neural networks. The course will also focus on optimization techniques like gradient descent and its variants. Programming will be an important component of the course. We will be using Python as our primary language. For implementation of algorithms, we will be using Tensorflow and Keras.	
Course Outcome: On successful completion of this course, the students will be able to: 1. Prioritize the collection and usefulness of data for a particular deep learning task. 2. Judge whether a particular problem can be solved using deep learning or not. 3. Critically analyze which architecture to use for a specific problem. 4. Design and implement computer vision algorithms using Tensorflow/Keras or pytorch framework. 5. Design and implement NLP algorithms using Tensorflow/Keras or pytorch framework.	

Syllabus (Theory)

Topics	**Lecture Hours**
UNIT – I Deep Neural Networks Generalization of logistic regression to deep neural networks. Cost functions. Optimization algorithms: Gradient descent, Stochastic gradient descent, Momentum, RMSprop, Adam.	9
UNIT – II Regularization Techniques Underfitting and overfitting of neural networks: bias and variance. L1, L2 and dropout regularization techniques, hyperparameter tuning.	6
UNIT – III Deep Learning for Computer Vision Basics of CNN: convolutions and pooling. Detailed understanding of Alexnet, ResNet, VGG-16, VGG-19 and inception architectures. Their implementations. Object recognition and face recognition.	12

UNIT – IV Deep Learning for Natural Language Processing Basics of RNN, LSTM, GRU, Bidirectional RNN, deep RNNs. Representations of words as vectors. One hot encoding and word embeddings. Learning word embeddings using word2vec, GloVe. Transformers.	13

Reference/Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press. Online available at http://www.deeplearningbook.org/

Additional Resources:

- Stanford CS230: Deep Learning

Coursera specialization on Deep Learning –

Course Title and Code: Understanding and Managing Conflict (CC1105)	
Hours per Week	**L-T-P: 2-0-0**
Credits	**2**
Students who can take	B.Tech. V Sem
Prerequisite	None
Weightage	Theory 60%, Practical -40%
Course Objectives: In today's increasingly complex and fragmented world, it is important to be able to resolve conflicts and build healthy relationships. Interpersonal and group dynamics is a course designed to prepare students to identify conflicts, manage emotions, analyze the situation and characters, and practice different frameworks to deal with conflicts	
Learning Outcomes: On successful completion of this course, the students should be able to: 1. Define a group and explain the stages of group development. 2. Describe conflicts and explain the types and causes of conflict. 3. Use inquiry and advocacy to engage with groups. 4. Give and receive feedback effectively. 5. Identify sources of conflict and manage them using different conflict handling styles.	

Course Syllabus (Theory):

UNIT I: Group Development and Personality Enhancement: Introduction to the stages of group development. Introduction to the personality, perception and learning as a source of difference in individuals and groups.

UNIT II: Conflict and Conflict Management Strategies: Names and types of conflicts, Intra and Interpersonal conflict, and conflict resolution strategies.

UNIT III: Emotional Intelligence: Development of emotional intelligence. Significance of empathy and feedback in intra and inter-personal development.

UNIT IV: Inquiry and Advocacy: Concept of Silence (Masking, Avoiding, Withdrawing) and Violence (Controlling, Labelling, Attacking).

Reference Online Course:

1. Fisher, R., & Ury, W. (2011). *Getting to Yes: Negotiating Agreement without Giving In*. Toronto, ON: Penguin Random House.
2. Harper, G. (2004). *The Joy of Conflict Resolution: Transforming Victims, Villains and Heroes in the Workplace and at Home*. Gabriola Island, BC: New Society Publishers.
3. Miles, E. W. (2013). Developing Strategies for Asking Questions in Negotiation. *Negotiation Journal*, 29(4): 383–412. doi: 10.1111/nejo.12034.
4. Morrison, E. W., & Rothman, N. B. (2009). Silence and the Dynamics of power. In J. Greenberg and M. S. Edwards (eds.), *Voice and silence in organizations*, pp. 111-133. Bingley, UK: Emerald Group Publishing

Course Title and Code: Reinforcement Learning	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	**B.Tech Sem VI**
Prerequisites	Deep Learning
Evaluation	Theory 40% Practical 60%

Course Objective: This course discusses the origin and evolution of the field of Reinforcement Learning (RL). This course will cover state of the art topics in RL as covered in various universities throughout the world. It will cover the basics of Markov Decision Processes, Planning, Model Based and Model Free RL, Value Function Approximation, Policy Methods, Exploration and Exploitation. A combination of deep learning and reinforcement learning called the deep reinforcement learning, has been more powerful and extremely successful. The course will also provide an introduction to this combination.

Learning Outcome:

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

1. Define the key features that distinguish RL from other forms of AI and non interactive machine learning.
2. Decide if a given specific problem should be formulated as a RL problem. If yes, be able to define it formally and state the best possible algorithm to be used for solving it.
3. Describe multiple criteria for analyzing RL algorithms and evaluate algorithms on metrics like, regret, sample complexity, computational complexity, etc.
4. Describe, compare and evaluate the two approaches of exploitation and exploration for measuring the performance of the algorithms.

Course Contents:

Unit I: Introduction to Reinforcement Learning, definitions and components of Markov Decision Processes, Dynamic Programming for RL,

Unit II: Bellman equations for value function and policy evaluation, model free policy evaluation, iterative methods, Monte Carlo methods, temporal difference learning, Q-learning.

Unit III: Model free vs model based RL, policy gradient methods, model based RL, off policy learning.

Unit IV: Exploration and exploitation in RL, epsilon-greedy exploration, upper confidence bound exploration, balancing exploration and exploitation.

Unit V: Deep reinforcement learning, deep Q-networks, policy gradient methods with neural networks.

Text Book:

There is no particular book for the course. However, the following serve as good references:

1. Sutton and Barto, "Reinforcement Learning: An Introduction", 2nd Edition.
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2022.

Reference Online Course:

1. **CS234, Reinforcement Learning, Stanford University.**
2. **CS188 Fall 2018, Artificial Intelligence: UC Berkeley.**

Course Title and Code: Ethics in AI	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Students who can take	B.Tech Sem VI
Prerequisites	Artificial Intelligence
Evaluation	Theory 40% Practical 60%

Course Objective: Machine learning has become an indispensable tool for creating intelligent applications, accelerating scientific discoveries, and making better data-driven decisions. Yet, the automation and scaling of such tasks can have troubling negative societal impacts. The ML algorithms are known to perpetuate and amplify societal bias that is present in the training datasets. The course aims to make the computer science students aware of such dangers that their applications may pose to the society, help them make applications that are good for the society.

Learning Outcome:

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

1. Analyze the isses of fairness, justice and truth in AI applications.
2. Apply recent techniques to detect and mitigate such algorithmic biases.
3. Devise methods to provide more transparency and explainability to the state of the art ML models.
3. Derive fundamental formal results on the limits of such techniques along with trade-offs that must be made for their practical application.

Course Contents:

Unit I: Introduction to ethics, role in AI. Ethical principles and frameworks guiding AI research and applications. Implications on human rights.

Unit II: Algorithmic bias and fairness. Gender / racial bias. Biased AI models and their potential consequences. Importance of designing fair AI systems.

Unit III: Explainability and transparency. Role in various fields like healthcare, finance, law enforcement, etc. Making AI systems for interpretable and explainable.

Unit IV: Privacy and robustness. Principles of data collection, storage, sharing, consent, localization and minimization. Rights of the users.

Unit V: . Regulating AI. Categorization of AI into various kinds that pose high and low risk to the society. Autonomous systems ethics. Issues of safety, liability and ethics while designing autonomous systems.

Text Book:

There is no particular book for the course.

Reference Online Course:

1. Coursera course on Ethics of AI
2. Explainable AI

Course Title and Code: Foundation of Blockchain and Smart Contracts (CS1226)	
Hours per Week	**L-T-P:2-1-2**
Credits	**4**
Students who can take	B.Tech(VII +V sem) Department Elective , BCA-V
Prerequisite	Database Management System, Any Programming Language
Weightage	Theory 60%, Lab 40%

Course Objectives: This course aims to provide an understanding of the essential concepts of blockchain technology by initially exploring the Bitcoin protocol followed by the Ethereum protocol to lay the foundation necessary for developing applications and programming for Blockchain Technology.

Learning Outcomes: On successful completion of this course, the students should be able to:

1. Be able to state core blockchain concepts, the benefits, and the limitations of blockchain technologies.
2. Be able to state the key differentiators for blockchain from other technology systems.
3. Develop, Test and Execute a smart contract.
4. Apply the consensus mechanism on application.
5. Identify use cases and develop the application.
6. Recognize the differences between the most prominent blockchain structures and permissioned blockchain service providers.

Course Syllabus (Theory)

Unit -1. Blockchain Overview : History and Origin of Blockchain (and Cryptocurrency) , Blockchain Architecture and design, Technical Concepts of Blockchain Systems : Physical Ledger Technology and Security , Digital Ledger Technology ,Digital Security Technology : Cryptographic Hash Functions ,Digital Signatures, Hash chain to Blockchain, Basic consensus mechanisms: Requirements for the consensus protocols, Proof of Work (PoW), Proof of Concept

Unit -2 DLT Technical Concepts: Mining, Distributed Consensus, Incentives, Proof of Work, Cryptosystems in practice ,Distributed Networks Attacks Introduction to Smart Contracts , Cryptocurrency, Types of Blockchain

Unit -3 The Ethereum 'Ecosystem' : Ethereum network, EVM, Transaction fee, Ether, gas, Solidity, Smart contracts, Smart Contract Languages. Solidity, Remix IDE etc.

Unit-4 NFTs and ERC-721 Tokens : Stable Coins and other ERC tokens, DeFi, Crypto exchanges, Cyber Security.

Unit -5 Emerging Applications of Blockchain in industry : Use cases of Blockchain in Agriculture, Bank, Healthcare, Insurance, Science, Supply chain etc. . Comparing Blockchain Ecosystems: Bitcoin, Ethereum, Hyperledger.

Text Books:

1. Imran Bashir: Mastering Blockchain. O'Reilly, Packt Publishing, 2017.
2. Narayanan, Arvind, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. *Bitcoin and cryptocurrency technologies: A comprehensive introduction*. Princeton University Press, 2016.
3. Mougayar, William. *The business blockchain: promise, practice, and application of the next Internet technology*. John Wiley & Sons, 2016

Reference Online Courses:

MOOC course : Blockchain Specialization by Coursera https://www.coursera.org/specializations/blockchain
NPTEL Course : Introduction to Blockchain Technology & Applications, By IIT Kanpur
https://nptel.ac.in/courses/106/104/106104220/

Course Title and Code: Multi-Dimensional and NoSQL Databases (CS1225)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. V Sem and VII sem; BCA V Sem
Prerequisites	Database Management Systems
Weightage	Theory 45% Lab 55%

Course Objectives: The student learns about data warehouse systems and implements such a system using Facts and Dimensions. This course also introduces the concepts of distributed databases. Building on this, the architectures of the different NoSQL databases are discussed along with the CRUD operations.

Learning Outcomes:

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

1. Conceptually design data warehouse (DW) system
2. Implement, Extraction Transformation Load (ETL) pipelines for DW on relational data stores
3. Write OnLine Analytical Processing (OLAP) queries DW system
4. Understand the fragmentation strategies of distributed databases
5. Understand the architecture of column and document NoSQL data stores
6. Build conceptual models and query NoSQL databases
7. Implement DW on a column store and document store

Course Syllabus (Theory):

Unit 1.**Decision Making and Data Warehousing:** Decision Making; OLTP versus OLAP, Data Warehouse and Data Marts, Data Warehouse Design: Multidimensional Model/ Data Modelling, Hierarchy of Data, Multidimensional Schema, Star Schema, Snowflake Schema, ETL, OLAP operations, OLAP Models

Unit 2.**Introduction to NoSQL Databases:** Evolution of DBs; Data fragmentation strategies. ACID Versus BASE; CAP theorem and its impact; PACLEC theorem and its impact. RDBMS vs NoSQL; Types of NoSQL Databases

Unit 3.**Column Family Databases**: Notion of column; Data Modelling using columns and query first model; CRUD operations of Cassandra; Architecture of Cassandra. **Document Store**: Document and its structure; Data Modeling of Documents, MongoDB architecture, Writing Aggregation Pipeline

Unit 4.**Graph Database**: Types of Graphs: Querying with CypherQL: Key Value Databases: Introduction to Redis, Redis Commands, Querying Data

Unit 5.**Future of warehousing using NoSQL databases**, Data Lakes versus Data Warehouses, Multi Model Database systems

Text Books:

1. Principles of Distributed Database Systems, T Ozsu and P. Valduriez, Prentice Hall, 2011, ISBN: 978-1-4419-8833-1.
2. Star schema the complete reference, Adamson
3. Cassandra: The Definitive Guide, Eben Hewitt and Jeff Carpenter, O'Reilly Media, 2nd Edition, 2016, ISBN-10: 1491933666
4. MongoDB: The Definitive Guide, Kristina Chodorow, 2nd Edition, O'Reilly Media, 2013, ISBN-10: 1449344682.
5. Graph Databases, Ian Robinson, Jim Webber and Emil Eifrem, O'Reilly Media, 2nd Edition, 2015, ISBN-10: 1491930896
6. Redis Cookbook: Tiago Macedo, Fred Oliveira, O' Reilly Media, July 2011, ISBN: 9781449305048

Reference Online Course:

1. Introduction to NoSQL Databases | Coursera
2. NoSQL systems | Coursera
3. IBM Data Warehouse Engineer Professional Certificate | Coursera

Course Title and Code: Object Oriented Programming (CS1101)	
Hours per Week	**L-T-P: 2-0-4**
Credits	**4**
Students who can take	B.Tech. V Sem
Prerequisite	None
Weightage	Theory 40% Practical 60%

Course Objectives: This Course will provide the students with a solid theoretical understanding of, as well as practical skills in, object-oriented programming. It focuses on object-oriented programming using JAVA and C++. The main concepts are Classes, Objects, Data Abstraction, Data Encapsulation, Overloading, Overriding, Polymorphism, Inheritance, Interfaces, Exception Handling, and Database Connectivity. This course also covers basic concepts for software design and reuse.

Learning Outcomes:

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

1. Apply object-oriented programming concepts using class and objects to solve problems.
2. Develop Java Programs using Object Oriented Programming Principles such as Classes, Objects, Data Abstraction, Data Encapsulation, Overriding, Polymorphism, Inheritance, and Interfaces.
3. Design, develop and debug programs using coding and documentation standards.
4. Incorporate exception handling in Java Programs.
5. Use overloading methodology on methods and constructors to develop application programs.
6. Use JDBC API connectivity in between Java Programs and database.

Course Contents:

Basics of Java & Decision Statements - Introduction to Java: Features of Java, Byte Code and JVM, JDK, JRE; Data types and Operators: Lexical Tokens, Identifiers, Keywords, Literals, Comments, Primitive Datatypes, ADT, Operator types and precedence, Statements and Flow Control: Conditional statements, looping, return, etc., Abstract data types and their specification. How to implement an ADT. Concrete state space, concrete invariant, abstraction function.

Control Structures, Methods & Constructors - Object Oriented Programming in Java: Object Lifetime & Garbage Collection.

Methods & Constructors - Constructor & initialization code block, Parameterized Constructor, Loops, Methods. Array & String - Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, Operation on String, Mutable & Immutable String, Collection Bases Loop for String, tokenizing a String, Creating Strings using StringBuffer.

OOP's Concept I - Class Fundamentals, Object & Object reference, Access Control, Modifiers, Methods in Java: Method Declarations, Method Signatures, Invoking Methods,

OOP's Concept II - Static vs. Instance Data Fields, Static vs. Instance Methods, Method Overloading, Encapsulation.

Inheritance, Composition, and Aggregation, Invoking Base Class Constructors, Overriding vs. Overloading, Polymorphism Overloading.

Interfaces - Inner Class & Anonymous Classes, Abstract Class, Interfaces.
Exception Handling - Introduction to Exception handling.

JDBC Programming - The JDBC Connectivity Model, Database Programming: Connecting to the Database, creating a SQL Query, Getting the Results, and Updating Database Data.
NOTE: Integrated Development Environments (IDEs) to be used in this Course are Eclipse or NetBeans – Both are compatible for Object Oriented Programming using Java.

Text Books:

1. Schildt, H. (2018). Java: The Complete Reference, Eleventh Edition. (n.p.): Oracle Press.
2. Liang, Y. D. (2015). Introduction to Java Programming: Comprehensive Version. United Kingdom: Pearson.
3. Horstmann, C. (2018). Core Java Volume I--Fundamentals. United Kingdom: Pearson Education.
4. Lafore, R. (2009). Object Oriented Programming using Turbo C++.

Reference Online Course:

https://www.geeksforgeeks.org/java/

https://www.w3schools.com/java/default.asp

https://www.coursera.org/specializations/object-oriented-programming

https://www.coursera.org/learn/object-oriented-java

Course Title and Code: Mobile Application Development (CS1205)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech Sem-V (CSE)
Prerequisites	None
Weightage	Theory -65%, Practical, Project and Assignments – 35%

Course Objectives: This Course is designed to offer learners an introduction to Android platform and related applications in the business world. The course will cover basics and security related issues in app deployment at Google Play Store. Different techniques will be discussed for app design for with real-time and static databases. The course lays the foundation for cross-platform app development course.

Learning Outcomes:

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

1. Develop high-level plans for script solutions for mobile and evaluate the post-production outcome.
2. Design scripts to meet given interface and media control requirements.
3. Use variables, properties and other code elements appropriately.
4. Implement and evaluate techniques for the installation of mobile applications and delivery via various channels.
5. Explain the principles of technologies which support media production and delivery on a variety of platforms.
6. Create event listeners for responding to events.

Course Syllabus (Theory)

Module I – Mobile Application Overview

Introduction to Mobile Computing, Introduction to Android development environment, Mobile Software Engineering, Design of application (view level).

Module II – Framework and User Interface Development

Frameworks and tools, Generic UI development, Android user (privileges), Designing the right UI, Multichannel and Multimodial UIs, Android intents and services.

Module III – Storing Retrieving Data with Real-time Database

Synchronization and replication of mobile data, Getting the model Right, Android storing and retrieving Data, Working with a content provider, Communications via network and the web, State Machine, Correct communications Model.

Module IV – Notifications, Alarming and Location

Performance and memory management, Android notifications and alarms, Graphics and UI Performance, Mobile agents and Peer-to-Peer architecture, Mobility and Location Based Services.

Text Books and References:

1. Android Cookbook, 2nd Edition by Ian F. Darwin Publisher: O'Reilly Media, Inc. Release Date: May 2017
2. Sam's Teach yourself Android Application Development. by Lauren Darcey and Shane Conder : 2012
3. Professional Android 4 Application Development by Reto Meier, 2012
4. Android Programming for Beginners by John Horton, 31 Dec 2015

5. https://developer.android.com/

MOOC Course Reference:

1. Advanced App Development in Android Capstone -Imperial College London
   Link: Advanced App Development in Android Capstone | Coursera
2. Android App Components - Services, Local IPC, and Content Providers - Vanderbilt University
   Link: Android App Components - Services, Local IPC, and Content Providers | Coursera
3. Java for Android - Vanderbilt University
   Link: Java for Android | Coursera

Course Title and Code: Game Design and Development (CS1227)	
Hours per Week	**L-T-P: 1-0-6**
Credits	**4**
Students who can take	B.Tech. CSE Semester V and VII (DE)
Prerequisite	None
Weightage	Theory 20% Lab 80%

Course Objectives: An introduction to VR game development using the Unity3D game engine. This is a project driven course where students will learn the cross-platform game engine Unity3D and develop a series of game projects. Students are expected to demonstrate the techniques taught in class through their projects.

Learning Outcomes:

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

1. Create multiple gaming applications, utilizing industry-standard tools and software.
2. Introduce them to scientific work in the areas of virtual reality, computer graphics, and artificial intelligence.
3. Gain programming capability to develop games.
4. Apply the mathematics and physics to game design.
5. Practice art creation, music and animations and various tools needed to create assets.
6. Learn to structure and define the duties of the game development team.

Course Syllabus (Theory)

Introduction to Unity and Unity Setup, Unity Basics, Using Prefab Objects, Getting Started with AI, Third Person Mechanics, Building a Scene, Unity Interface, Re-arranging different panels such as game window, console window, Project Explorer, Scene window etc.

Creating new layouts, Saving a layout, Understanding 3D Game Objects, Components of Game Objects, Scaling, rotating, zooming and positioning game objects, Learning useful shortcuts, Building a wall using Cubes, Snapping, Unity Scripts, Methods of Mono Behaviour class, Materials, Prefabs, Adding Lights to Game Object, Moving a game object, Rotating and scaling game object using script, Moving game, objects using keys.

Creating a game object at run time, Physics vs Kinematic movements in Unity, PhysX engine, Drag, Collider, Activating / De-activating a game object, Enabling / Disabling game objects, Instantiating Game Objects, Destroying Game Objects.

Reference Books

1. Blackman, S. (2013). Beginning 3D Game Development with Unity 4: All-in-one, multi-platform game development. Apress.
2. Lanzinger, F. (2020). 2D Game Development with Unity. CRC Press.
3. Sung, K., & Gregory, S. (2019). Basic Math for Game Development with Unity 3D. Apress.

Coursera-

Game Design and Development with Unity 2020 Specialization
https://www.coursera.org/specializations/game-design-and-development

Unity and C# basics
https://www.coursera.org/learn/unity-and-c-basics

Course Title and Code: Digital Image Processing and Introduction to Quantum Computing (EE1224)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. CSE-V Semester, ECE VI Semester
Prerequisites	Calculus, Linear Algebra and Differential Equations
Weightage	Theory -60%, Practical and Projects – 40%
Course Objectives: The course introduces with the basic principles, techniques, algorithms of image processing and how to use them to solve problems of commercial and scientific interests. Students will be involved in real world project on crop monitoring using quantum computation.	
Learning Outcomes: On successful completion of this course, the students should be able to: 1. Ascertain and describe the basics of image processing concepts through mathematical interpretation. 2. Acquire the knowledge of various image transforms and image enhancement techniques involved. 3. Demonstrate image restoration process and its respective filters required. 4. Stride convolution filter with different step size, observe the effect of padding and pooling in the image matrix. 5. Represent images into various quantum image formats (Qubit Lattice, Flexible Representation of Quantum Images (FRQI), Realket) and perform geometric/ color transformations.	

Course Syllabus (Theory):

Unit I: Introduction to Image Processing: Background and Applications, Elements of Visual Perception, Brightness Adaption and Discrimination, Statistical Background, Image representation formats.

Unit II: Image Transforms- Two-dimensional Fourier Transform- Properties – Properties of 2D DFT, Hadamard Transform, Walsh and Discrete Sine/ Cosine Transforms, Walsh Transform, Discrete Cosine Transform, Wavelet Transforms, Wavelet Functions. Transform operations using filters.

Unit III: Convolution, Filters-Mean Filters, Order Static Filters, Strided convolution, Padding Images, Pooling.

Unit IV: Image Processing using Quantum Computing: qubit, logic gates, Quantum circuits, Quantum Fourier Transform, Quantum Image Representation through quantum states, Transformations using quantum circuits.

Textbooks:

1. Digital Image Processing -S Sridhar, Oxford University Pres, Second Edition.
2. Quantum Computation and Quantum Information: M. Nielsen & I. Chuang, Cambridge University Press, 2010 edition.

Online Courses:

Digital Image Processing by Dr Prabir Kumar Biswas, NPTEL, Swayam.

Course Title and Code: IDEA TO BUSINESS MODEL (ED1102)	
Hours per Week	**L-T-P: 4-0-0**
Credits	**4**
Students who can take	B.Tech /BCA V Semester Elective
Pre-requisite	None
Weightage	Exam, Presentations, Assignments, Activities and Quiz 80%; Project 20%

Course Objectives:

To encourage students to nurture their entrepreneurial traits and think creatively to develop innovative ideas/products for commercial exploitation.

Course Outcomes:

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

1. Identify problem worth solving through design thinking.
2. Identify customer segment and niche for specific markets.
3. Craft Value Preposition Canvas.
4. Analyse competition
5. Create business model using Lean Canvas Template
6. Design and validate solution demo and MVP.
7. Analyse cost, revenue, key channels and pricing model for the venture.
8. Craft positioning statement of a new venture.
9. Classify the different sources of funding

TOPICS

1. Overview of Entrepreneur and Entrepreneurship
2. Self-Discovery & Entrepreneurial Thinking
3. Opportunity Discovery
4. Identify Customer
5. Value Preposition Canvas
6. Competition Analysis
7. Business Model
8. Minimum Viable Product
9. Money (Revenue, Costs, Pricing and Financing)
10. Marketing and Sales
11. Funding your Venture
12. Support (Institutional and Government policies)
13. Project

TEXT BOOK AND ADDITIONAL READING MATERIALS

NextGen (It is a leading digital learning platform provided by Wadhwani Foundation)

Additional Reading Material

1. Robert D Hisrich, Michael P Peters, Dean A Shepherd (2017). Entrepreneurship/10e..New Delhi; Tata McGraw-Hill.
2. Poornima M Charantimath (2012). Entrepreneurship Development Small Business Enterprises. New Delhi: Pearson.
3. Rajeev Roy (2011). Entrepreneurship. New Delhi: Oxford 4. Arya Kumar (2015). Entrepreneurship: Creating and Leading an Entrepreneurial Organisation. New Delhi: Pearson.

4. Vasant Desai (2016). Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House.
   Note: Latest edition of the readings will be used

Course Title and Code: Numerical and Scientific Computing (AS2202)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Pre-requisite	None
Students who can take	B. Tech and BCA Semester-V Elective
Weightage	Theory – 70%, Lab – 30%

Course Objectives:

This course aims to introduce advanced numerical methods to model engineering systems and to solve them using various computational techniques. Laboratory sessions involve the application of numerical analysis to various physical problems.

Learning Outcomes: After course completion, the student will be able to:

1. demonstrate an understanding of common numerical methods and used them to obtain approximate solutions to otherwise intractable mathematical problems.
2. develop numerical techniques for different mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. analyze and evaluate the accuracy of common numerical methods.
4. write efficient, well-documented programming code and present numerical results in an informative way.

Course Syllabus (Theory)

Modeling, Computers, and Error Analysis: Mathematical Modeling and solution using Programming and Software, Computer Arithmetic and Errors: Approximations and Round-Off Errors, Truncation Errors, and the Taylor Series.

Transcendental and polynomial equations: Solution of non-linear Equations: Bracketing Methods, Open Methods, Roots of polynomials.

Linear Algebraic Equations: LU Decomposition and Matrix Inversion, Iterative methods for solving system of linear equations, finding eigenvalues and eigenvectors.

Interpolation and approximation: Interpolation for equally and unequally spaced points, Lagrangian Polynomial.

Numerical Differentiation and Integration: Numerical Differentiation and Integration, Newton-Cotes Integration Formulae.

Ordinary Differential Equations: Difference equation, Single step methods, Stiffness and Multistep Methods, Predictor-corrector method.

Partial Differential Equations: Finite Difference: Elliptic and Parabolic Equations.

Textbooks:

1. M.K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, New Delhi.
2. JV Lambers, ACS Mooney, VA Montiforte, Explorations in Numerical Analysis: Python Edition, WSPC (January 18, 2021).

Reference Books:

1. Q Kong, T Siauw, A Bayen, Python Programming, and Numerical Methods: A Guide for Engineers and Scientists, Academic Press; 1st edition (December 16, 2020)
2. K. E. Atkinson, Introduction to Numerical Analysis, John Wiley and Sons.
3. Steven C Chapra, Raymond P Canale, Numerical Methods for Engineers, 6/e, Mc Graw Hill

4. Srimanta Pal, Numerical Methods: Principles, Analyses, and Algorithms, Oxford University Press, New Delhi.
5. Cheney and Kincaid, Numerical Methods and Applications, Cengage Publications, New Delhi.
6. Cleve B. Moler, Numerical Computing with MATLAB, Prentice Hall of India, New Delhi.

Course Title and Code: Advanced Statistics (AS1202)	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Pre-requisite	None
Students who can take	B.Tech Sem V (Open Elective)
Weightage	Theory – 100%

Course Objectives- To familiarize students with concepts of multiple random variables and their properties to use them to analyze real-life problems. This course also focuses on developing an understanding of regression models, data analysis, model building, interpretation of results and statistical computation.

Learning Outcomes:

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

1. identify, formulate, and derive various properties of probability distributions and density functions of one and more random variables.
2. choose appropriate descriptive properties to summarise a variety of data sets.
3. apply the concepts of the central limit theorem and algebra of random variables to analyze linear systems.
4. analyze a system of multiple random variables using the appropriate regression model.
5. model experiments as processes and analyze them using ANOVA.

Course Syllabus (Theory)

Random Variables

Random variables, Distribution and density functions of random variables, Discrete and continuous random variables, Gaussian, Exponential, Rayleigh, Cauchy, Uniform, discrete Uniform and conditional distributions, general properties of distributions.

Multiple Random Variables

Joint and marginal distributions for discrete and continuous random variables. Joint moments, Conditional distributions, correlation coefficient, statistical independence. Multiple random variables, expected value, Variance, standard deviation, moments of multiple random variables.

Operations On Multiple Random Variables

Central limit theorem, Chebyshev's Inequality, covariance, variance of a linear combination of random variables, and distribution of sums of independent random variables.

Regression Analysis

Introduction to the regression model, Types of regression models, Least square estimators, Estimation of the regression coefficients and error variance, Inferences for the regression coefficients, Predicting future observations, Inverse prediction, and regulation. Multiple linear regression models.

Design of Experiments

Analysis of variance, one-way ANOVA, two-way ANOVA, and nonparametric tests.

Recommended MOOC :

1. **https://www.coursera.org/learn/linear-models**
2. https://www.coursera.org/projects/linear-regression-numpy-python

Reference Books:

1. J. Susan Milton and Jesse C. Arnold, 'Introduction to Probability and Statistics', McGraw Hill Education.

2. Papoulis, ‘Probability, Random Variables And Stochastic Processes’, TMH.
3. VK Rohatgi and AK Saleh, ‘An Introduction to Probability and Statistics’, Wiley India.
4. Sheldon M. Ross, ‘Stochastic Processes’, 2ed, Wiley.
5. Shumway & Stoffer (2011) Time Series Analysis and its applications, with examples in R , 3rd edition, Springer.
6. K. L. Chung, ‘Introduction to Probability Theory with Stochastic Processes’, Springer International Student Edition.
7. Applied Linear Statistical Models by Kutner, Nachtsteim, Neter and Li (5th edition).

Course Title and Code: Introduction to Robotics (ME1226)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. V Semester
Prerequisite:	Calculus and Applied Mechanics
Weightage:	Theory - 60%, Practical and Projects - 40%
Course Objectives: This is a first level course where students will be introduced to the fundamentals of robots required to get started in the field of robotics.	
Learning Outcomes: On successful completion of this course, the students should be able to: 1. Understand basic robotic terminologies. 2. Implement various sensors and actuators to plan robotic motion and control. 3. Design and develop basic robotic system.	

Course Syllabus (Theory):

Unit I Introduction: Basic concepts, elements of robotic systems, i.e., robot anatomy, DOF, misunderstood devices, classification of robotic systems, Resolution, accuracy, repeatability, dexterity, and compliance of robots, Principles & strategies of automation, and Applications of robots.

Unit II Drives and Control for Robotics: Type of drives and transmission systems, Actuators and their selection. Types of controllers, and Introduction to closed loop control. Robot motion, planning and control.

Unit III Grippers and Sensors for Robotics: Types of grippers and design of robotic gripper. Sensor's classification, selection and applications, Need of sensors and vision system in the working and control of a robot.

Unit IV Related Topics in Robotics: Socio-economic aspect of robotization. Economical aspects for robot design, Safety for robot and standards, Basic robot programming, Need and application of AI, New trends in robotics.

Textbooks:

1.Kevin M. Lynch and Frank C. Park, Modern Robotics Mechanics, Planning, and Control Cambridge University Press (2017).

2.S K Saha, Introduction to Robotics, McGraw Hill Education (India) Private Limited (2014).

3.DK Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019).

4.S. B. Niku, Introduction to Robotics - Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., (2020).

Online Courses for Reference:

1.Introduction to Robotics by Dr. Krishna Vasudevan, Dr. Balaraman Ravindran, Dr. T Asokan, IIT Madras https://nptel.ac.in/courses/107106090.

2.Introduction to Robotics by Prof. Harry Asada and Prof. John Leonard, MIT Opencoursware, https://ocw.mit.edu/courses/2-12-introduction-to-robotics-fall-20050.

3.Robotics by Dr. D K Pratihar, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_me56/preview.

4.Sensors and Actuators by Prof. Hardik Jeetendra Pandya, IISc Bangalore https://nptel.ac.in/courses/108108147.

Course Title and Code: Integrating Design, Technology and Business (IL1211)	
Hours per Week	**9 sessions (3 hours each)**
Credits	**4**
Students who can take	B. Tech. V Semester
Prerequisite	The course is open to Vth semester students of B.Tech/BBA/B.Des programmes being offered by the University. The course will be restricted to 36 students, with 12 from each discipline (Design, Engineering and Management). As the course will require group working for stretched periods beyond classroom hours, it is highly desirable that participating students stay in hostels during the entire course journey. Students under academic warning/probation are advised to refrain from applying for this course.
Weightage	Design Conceptualization/Process 30%; New Technology Application 30%; Business Model (BMC) 40%

Course Objectives: Organizations in present times are operating in a highly competitive and an uncertain environment. Innumerable stories exist about products, services and business models that once ruled the market but have now ceased to exist. Many new industry structures, business models, products and services have emerged in the recent past. AirBNB, Uber/Ola, PayTM, Zomato/Swiggy etc. are just a few examples that have transformed the industry structures.

Design-led and technology-driven products are becoming the order of the day. Even the startup/entrepreneurial eco-system in the country is increasingly becoming conducive to these developments. All these (and many more) changes need a corporate workforce that has a strong interdisciplinary perspective.

Today's designers, technocrats and business managers cannot afford to operate in silos and must effectively collaborate. The present course has been designed and is being offered to meet this very need.

It aims to develop future-ready professionals with skills and capabilities that will enable them to collaborate with cross-functional teams and inter-disciplinary forces while they identify business problems/opportunities from the real-world and design and develop technology-driven marketable solutions to solve the identified problems/tap the business opportunities.

The present course would be offered as a project-based learning opportunity to the students of B.Tech, BBA, and B.Des students at the University. The focus of the course would be to identify a real-world business problem/opportunity, develop proposed solution to solve/tap it using contemporary technologies and prepare a business plan to commercialize it. Groups of students from all the three disciplines shall be working together at every stage of the course and producing their proposed plan.

To make it a little specific, the context for the current cohort will be Healthcare Sector while the target technologies will broadly be AI/ML, IoT (Internet of Things), Blockchain and AR/VR. The course will involve classroom interactions with experts in the technology, design, and management domain. There will also be expert sessions from the healthcare sector for facilitating the identification of challenges and opportunities in the same.

Through these interactions and collaborative working, students will learn about the development of modern technology applications using design principles and prepare a business plan that is ready for commercialization. The course will also provide an opportunity for the students to learn how to meaningfully engage themselves in an intelligent discussion with members across diverse functions.

Detailed Session Plan

The course will be delivered over nine weeks during Aug-Oct'23. There will be one session of three hours every week. During these sessions, the students will be exposed to the concepts relating to recent technology applications, business models, and strategic design management.

The sessions will involve lectures by domain experts, invited talks by experts, classroom/lab exercises besides having a mix of several other pedagogical tools. Besides these sessions, students will be required to work with their respective group members on the key takeaway tasks/assignments and achieve the weekly milestones as indicated in the session schedule. An indicative schedule is presented herewith which may be fine-tuned depending upon the progress of the groups and availability of experts.

Week/Session	Focus Area/Broad Topics	Milestones/ Remarks
W1/S1	**Technology** Introducing the Context and Technology Domain	
W2/S2	**Design Thinking & Process** Preliminary Investigation for identifying opportunities using Design principles	
W3	**Field Work** Identification of real-world problems worth solving	
W4/S3	**Design & Technology** Discussion & Evaluation of alternative applications	
W5	**Field Work** Narrowing down the solution space	
W6/S4	**Business** Use Business Model Canvas to identify business issues	
W7-W8	Sessions in Workshop mode on business plan and prototype development	
W9	Final Submissions and Presentation	

Course Title and Code: Introduction to IoT and Automation Projects (EE1222)	
Hours per Week	**L-T-P: 2-1-2**
Credits	**4**
Students who can take	B.Tech. Semester V CSE (Open Elective)
Prerequisite	Computer Organization and Architecture, Programming -I
Weightage	Theory -40%, Practical– 60%

Course Objectives-

The course aims to introduce Internet of Things (IoT) technologies for developing different applications. It focusses to develop skills for designing, implementing and testing solutions for automation using IoT.

Learning Outcomes:

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

1. Recommend sensor and networking technologies for an IoT application.
2. Explore various protocols and data conversion process using various IoT devices.
3. Use cloud servers for data streaming and analysis.
4. Design and implement a complete project in IoT/Automation using microcontroller/SOC interfaced with sensors or any other automation hardware/tools,
5. Deploy techniques to conserve bandwidth/energy/other resources and achieve cost economy for project.

Course Syllabus (Theory):

UNIT I Definition and Characteristics of Internet of Things (IoT) - - Physical Design of IoT - Logical Design of IoT - IoT Functional Blocks, network configuration, emerging technologies for IoT: RFID, Wireless Sensor Networks.

UNIT II: Physical parameters, Measurement principles, Calibration, Amplification, Mechanical and Electrical Actuators, Closed loop systems for automation.

UNIT III – Communication modules – Bluetooth – Zigbee – WiFi – GPS - IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP) – MQTT - Wired Communication (Serial, I2C and SPI) - Power Sources.

UNIT IV: IoT Endpoints: ARM architecture, Raspberry pi, ESP8266 firmware, Interfacing sensors to edge endpoints. Uploading data to cloud for visualization and analysis.

Textbooks:

1. Arshdeep Bahga and Vijay Madisetti Internet of Things: A Hands-on Approach, Universities Press.
2. Rajkamal, Internet of Things, Architecture and Design Principles, Mc. Graw Hill Education (India) Pvt Ltd.

Reference Book:

T.A. Kern, C. Hatzfeld and A. Abbasimoshaei, Engineering Haptic Devices, Third Edition, Springer.

MOOC courses

1. The Raspberry Pi Platform and Python Programming for the Raspberry Pi
https://www.coursera.org/learn/raspberry-pi-platform?specialization=iot
2. AWS Cloud Technical Essentials

https://www.coursera.org/learn/aws-cloud-technical-essentials.

Course Title and Course Code: **Computational Game Theory and Applications (EE1223)**	
Hours per Week	**L T P: 3 1 0**
Credits	**4**
Students who can take	**BTech Semester-V**
Prerequisite	Calculus, Probability and Statistics, Mathematical Modeling, Knowledge of computer programming
Weightage	Theory - 60%, Project, Quiz, Viva, and Assignments – 40%

Course Objectives:

The course focuses on areas of game theory that are relevant for engineering applications. The emphasis is both on theoretical principles and on the application of the theory to problem formulation and problem solving. The course covers a wide range of topics, from different models of non-cooperative games and related equilibrium concepts to cooperative games.

Learning Outcomes:

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

1. Explain the key concepts of preferences, utility, and decision-making under certainty and uncertainty.
2. Apply the key models and solution concepts of non-cooperative game theory, including both strategic form and extensive form games.
3. Evaluate the importance of competitive and cooperative factors in a variety of decision problems.
4. Analyse the key models and solution concepts of cooperative game theory, including TU and NTU games.
5. Analyze games with imperfect and incomplete information.

Course Syllabus :

Unit-1: Introduction

Introduction to game theory, routing games and mechanism design; Strategies, costs, and payoffs; Prisoner's dilemma, Nash Equilibrium, Strategic games; Best response; Dominant strategies; Pure strategy v/s Mixed strategy.

Unit-2: Preferences, Utility, and Goals

Preference relations and their interpretation, utility as a numeric model of preference, Decision-making under uncertainty: preferences over lotteries; Von Neumann and Morgenstern utility functions; expected utility and expected utility maximisation, Paradoxes of expected utility maximization; framing effects and prospect theory.

Unit-3: Bayesian Games

Definition of a Bayesian Game and Bayesian Nash Equilibrium, Games with incomplete information, Bayesian-Nash equilibrium, Perfect Bayesian equilibrium, Refinements of PBE, Applications to spence job-market signaling game, oligopoly games with asymmetric information etc.

Unit-4: Cooperative and Non-Cooperative Games

Noncooperative Game Theory: Strategic form games, existence of Nash equilibrium, computation of Nash equilibrium, matrix games, minimax theorem, extensive form games.

Cooperative Game Theory: Correlated equilibrium, two person bargaining problem, coalitional games, core, shapley value and its implications, Transferable utility (TU) and nontransferable utility (NTU) games.

Unit-5: Engineering Applications

Game theory based control approach for smart grid operation, power control schemes, reactive power management, demand side management, electric vehicle charging, storage management, electricity pricing etc.

MOOC Course Link:

https://www.coursera.org/learn/game-theory-1?action=enroll&courseSlug=game-theory-1&showOnboardingModal=check

https://online.stanford.edu/courses/soe-ycs0002-game-theory

Reference Books:

1. Dutta, Prajit K., “Strategies and Games : Theory and Practice” MIT Press.
2. Vladimir Mazalov, “Mathematical Game Theory and Applications” John Wiley & Sons, Ltd.
3. Ken Binmore, “Playing for Real: A Text on Game Theory” Oxford University Press.
4. Erich Prisner, “Game Theory Through Examples” The Mathematical Association of America.
5. Steven Tadelis, “Game Theory: An Introduction” Princeton University Press.

Course Title and Code: Virtual Reality Lab (CS1221)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	B.Tech. CSE Semester V
Prerequisite	None
Weightage	Practical 100%

Course Objectives: This course presents an introduction to virtual reality technologies, with an emphasis on designing and developing interactive virtual reality experiences. The course will cover 3-D modelling, interaction techniques, and specific application areas. Students will be able to work on real-life projects using VR technology.

Learning Outcomes:

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

1. Understand how the design of VR technology relates to human perception and cognition.
2. Apply the acquired knowledge for the analysis and design of VR systems.
3. Apply and use several types of Hardware and software in Virtual Reality systems.
4. Gain first-hand experience with using virtual environment technology, including 3D rendering software, tracking hardware, and input/output functions for capturing user data.
5. Develop and deploy VR (Virtual Reality) applications using Blender and Unity/ Unreal tools.

Course Syllabus (Theory):

Hands-on Modeling using Blender

- Overview
- Start Modeling
- Installing Blender
- Blender: Essential Training
- Blender: Essential Concepts Summary
- Optimization and Rendering
- Create interactive 3D models
-

Introduction to Virtual Environment Technology

- VR and its relation to humans
- The relation of VR to research, training, design, and manufacturing.
- An overview of VR applications.
- VR design: perceptual and cognitive factors.

Introduction to Unity/Unreal Engine:

- Interface overview and navigation
- Creating a new project, importing standard assets, adding a player character
- Tracking, Latency, Field of View in Real life,
- Fidelity, depth, isolation, smell, range of motion (DoF)
- Sensory Influence: Kinetics, Spatial Audio, Haptics, Other senses?
- Megascans plugin for Unity/Unreal

Note - Tools recommended: - Blender, Unity/Unreal

FINAL PROJECT: Building one VR Application.

Reference Books:

1. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, “Creating Augmented & Virtual Realities”, 1stedition, O’REILLY, 2019.
2. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016
3. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013
4. Fei GAO. Design and Development of Virtual Reality Application System, Tsinghua Press, March 2012.
5. Guangran LIU. Virtual Reality Technology, Tsinghua Press, Jan. 2011.

Recommended MooC:

Introduction to Virtual Reality– Coursera

https://www.coursera.org/learn/introduction-virtual-reality#syllabus

Introduction to Augmented Reality and ARCore– Coursera

https://www.coursera.org/learn/ar

Course Title and Code: Geographical Information Systems Lab (GIS) (CE1114)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	B.Tech V sem (B Tech CSE, EEE and ME), BCA IV Sem
Prerequisite	None
Weightage	Practical 100%

Course Objectives: This course presents an introduction to virtual reality technologies, with an emphasis on designing and developing interactive virtual reality experiences. The course will cover 3-D modelling, interaction techniques, and specific application areas. Students will be able to work on real-life projects using VR technology.

Learning Outcomes:

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

1 Assess the various sources for remote sensing data and analyze the various type of images.

2 Analyze the data acquisition and data output through GIS, with the help of open-source tool of QGIS and Python.

3 Automate GIS processes with Python-based plugin development for QGIS.

4 Incorporate GIS in resource management and climate change applications

Course Syllabus

- Remote sensing satellites and their data products, Sensors and orbital characteristics, Satellite Image - Characteristics and formats, Introduction to Image rectification, Image Enhancement, Land use and land cover classification system.
- Basic concepts of geographic data, GIS and its components, Data acquisition, Raster and Vector formats, Topology and Data models, Spatial modeling, Data output
- Applications of GIS: Climate change, Natural resources management, Forest management, Water Resources management, Drought Management, Location-based services.

Syllabus (Practical with QGIS and Python)

QGIS experiments

1. Creating and Exploring a Basic Map
2. Classifying and Creating Vector Data
3. Laying Out of the Maps
4. Classifying and Creating Raster Data
5. Terrain Analysis
6. Raster to Vector Conversion
7. Hydrologic Analysis

Python-based experiments

1. Working with Shapely package and geometric objects
2. Vector data analysis with Geopandas
3. Geocoding in Geopandas
4. Analyzing raster data and automatically detecting features
5. Working with Maps
6. Plugin development and integration with QGIS

Links to Some Sample Github implementations (for plugin development)

https://github.com/ConservationInternational/trends.earth

https://github.com/ghtmtt/DataPlotly

Talks on Python integration with QGIS
https://vimeo.com/106874213
https://www.youtube.com/watch?v=z_QEi212DEQ

Text /Reference Books:
1. Erik Westra - “Python Geospatial Development”, Packt Publishing.
2. Joel Lawhead - “QGIS Python Programming Cookbook”, Packt Publishing.
3. Bhatta B., “Remote sensing and GIS”, Oxford University Press, 2011.
4. Satish G., “Advanced Surveying: Total Station, GIS and Remote Sensing”, Pearson, 2011.
5. QGIS 3 and PyQGIS online documentation files.

https://autogis-site.readthedocs.io/en/latest/
https://nptel.ac.in/courses/105/108/105108077/

Course Title and Code: Minor Project (PR1103)	
Credits	2
Students who can take	B.Tech Sem VI
Prerequisites	None
Weightage	Report and Project 100%

Course Objectives- This course offers an opportunity to apply and extend knowledge learned throughout the program to solve real world issues. The minor projects undertaken span a diverse range of topics, including design, simulation, and experimental studies. The course emphasizes, facilitating student learning in technical, project implementation and presentation spheres.

Course Outcome:

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

1. Identify and formulate industrial and societal problems.
2. Design engineering solutions for complex problems.
3. Develop/fabricate, and implement solutions for identified problem.
4. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Course Title and Code: Critical Thinking for Decisions at Workplace (CC1106)	
Hours per Week	**L-T-P: 2-0-0**
Credits	**2**
Students who can take	BTech Semester VI
Prerequisite	None
Weightage	Theory 40% Practical 60%
Course Objectives- In today's world, the idea of right and wrong is being challenged by businesses, use of technology, economic conditions, and norms of societies. The relevance of a well-reasoned decision is crucial. This course intends to make students take better decisions keeping in mind purpose, context, and ethics.	
Learning Outcomes: The students will be able to: 1 Apply strategies of Critical Thinking to examine organisational problems through positive inquiry 2 Describe and examine suitable problem-solving and ethical decision-making processes 3 Choose the simplest and logical decision among multiple alternatives 4 Evaluate solutions and count on possible risks based on purpose, context and ethics	

Course Syllabus:

Topics
• Importance of decision making at workplace • Robust decision making by David G Ullman • Taxonomy of decision making by Rowe and Boulgarides • Factors impacting decision-making • Concept of enquiry circle • Theories of ethics (Teleological, Deontological, Virtue Ethics, Conduct Ethics, Rights based, Utilitarianism, Hedonism, Egoism) • Concept of moral development by Kohlberg • Role of ethics and values in decision Making • Role of Stakeholders in decision making. • Root cause analysis

Suggested Readings

1. Jonah Lehrer, 2009: **How we Decide.** Houghton Mifflin Harcourt, Boston, New York
2. Chip Heath and Dan Heath, 2013. **Decisive: How to Make Better Choices in Life and Work.** Crown Business, ISBN 0307956393
3. John S. Hammond, Howard Raiffa, Ralph L. Keeney, 2002. **Smart Choices: A Practical Guide to Making Better Decisions.** Crown Business, ISBN 0767908864
4. Ramesh K. Arora, **Ethics, Integrity and Values in Public Service.** New Age International Publishers, New Delhi.
5. Bradley H. Dowden, 1993. **Logical Reasoning.** Wadsworth Publishing Company, Belmont, California, ISBN 0534176887

Course Title and Code: Big Data Engineering (CS1312)	
Hours per Week	**L-T-P: 2-0-4**
Credits	**4**
Students who can take	B.Tech CSE Sem VI/BCA Sem VI
Prerequisite	Operating System, Database Management System
Weightage	Theory 20% Practical 80%

Course Objectives- The main goal of this course is to help students learn, understand, and practice modern big data technologies for scaling up data science techniques focusing on industry applications. This course builds upon the foundations laid on operating system, databases, and machine learning.

Learning Outcomes:

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

1. Identify the characteristics of datasets and compare the trivial data and big data for various applications.
2. Develop Big Data Solutions using Hadoop Eco System
3. Select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.
4. Integrate Data Science libraries in Python with big data technologies.
5. Utilize big data technologies for data analysis.

Course Syllabus (Theory):

Introduction to Big Data and Hadoop

Data Overview, Industry Applications, Case Studies, Understanding Big Data; Hadoop overview: Hadoop Introduction, Hadoop architecture, HDFS Introduction, HDFS architecture, MapReduce v 1.0 and YARN differences and their architecture, Hadoop Security, Hortonworks Data Platform (HDP)

Hadoop Eco System

Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions.

Hbase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

Sqoop: Sqoop commands

Big Data Analytics

Introduction to Big Data Analytics, Descriptive analytics, Data-driven Decision Making, Web scraping and data acquisition, Data Pre-processing, Data visualization, Model Development, Model Validation, Model Diagnostics, Model Deployment**,** Regression, Classification and Clustering methods, Dimensionality reduction, Network analysis, Ethics of big data

Reference Books:

1. U Dinesh Kumar, “Business Analytics – The Science of Data Driven Decision Making”, Wiley, 2017.
2. Benjamin Bengfort and Jenny Kim. Data Analytics with Hadoop: An Introduction for Data Scientists. O'Reilly Media, 2016.
3. Jake VanderPlas. Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media, 2016

Course Title and Code: Full Stack Web Development with REACT (CS1212)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. CSE VI
Prerequisites	Any Programming language, Database Management Systems
Weightage	Theory 30% Practical 70%

Course Objectives: This course will equip the students with understanding and skills for MERN stack web development using MongoDB database, NodeJS, Express and React library.

Learning Outcomes:

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

1. Develop high-level plans for script solutions for web to evaluate the post-production outcome.
2. Implement front end web design in ReactJs.
3. Design scripts to meet given interface and media control requirements.
4. Devise, carry out and evaluate functional test strategies of web design.
5. Implement and evaluate techniques for the installation of cross platform mobile applications and delivery via various channels.
6. Implement NoSQL databases using MongoDB, work within a Node.js environment and Express framework.
7. Communicate to the client side through a RESTful API and web services.

Course Syllabus (Theory):

JavaScript application development and the React library, React Router and Single Page Applications, Reactstrap, React Native UI Elements and Redux.

React Native Alerts, Animations, Gestures, and Persist Redux Store, Accessing Native Capabilities of Devices: The Expo SDK

Front-end Web UI Frameworks Overview: Bootstrap, Bootstrap CSS Components, Bootstrap JavaScript Components

Web Tools - Bootstrap JavaScript, CSS preprocessors, Less and Sass, automation using NPM scripts, and task runners like Grunt and Gulp.

Introduction to Server-side Development - Node, Node modules and the Node HTTP server, Express framework and set up a REST API using Express.

Data storage with MongoDB, the popular NoSQL database, Express generator, interaction with MongoDB from a Node application, REST API server with Express, Mongo and Mongoose, Mongoose population, secure communication using HTTPS.

Text Books:

1. Fullstack React Native: Create beautiful mobile apps with JavaScript and React Native
2. Learning React: Functional Web Development with React and Redux
3. Practical React Native: Build Two Full Projects and One Full Game using React Native

Course Title and Code: Cloud Computing Architecture (CS1217)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. CSE Sem VI
Prerequisites	Operating Systems, Computer Networks, Database Management Systems, Computer Organisation and Architecture
Weightage	Theory 40% Practical 60%

Course Objectives:

The course presents a top-down view of cloud computing, from applications and administration to programming and infrastructure. The main focus is on deployment of solution elements, including infrastructure components such as networks, systems and applications services in the cloud infrastructure. This course builds upon the Operating
System, Computer Networks, Database, Computer Architecture.

Learning Outcomes:

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

1. Apply fundamental concepts in cloud infrastructures to understand the trade-offs in power, efficiency and cost
2. Build and deploy cloud applications that are resilient, elastic and cost-efficient
3. Analyse the trade-offs between deploying applications in the cloud and overthe local infrastructure.
4. Deploy applications over commercial cloud computing infrastructures, i.e.,Google Cloud
5. Analyse the performance, scalability, and availability of the underlying cloud technologies and software

Course Syllabus (Theory):

Cloud Computing Overview: Definition and evolution of Cloud Computing, Enabling Technologies, Service and Deployment Models, Popular Cloud Stacks and Use Cases, Benefits, Risks, and Challenges of Cloud Computing, Economic Models and SLAs, Topics inCloud Security

Cloud Infrastructure: Historical Perspective of Data Centres, Datacentre Components: IT Equipment and Facilities, Design Considerations: Requirements, Power, Efficiency, & Redundancy, Power Calculations, PUE and Challenges in Cloud Data Centres, Cloud Management and Cloud Software Deployment Considerations

Google Cloud Platform Fundamentals: Google App Engine, Google Compute Engine, Google Kubernetes Engine, Google Cloud Storage, Google Cloud SQL, and BigQuery, Google CloudResource Manager hierarchy and Google Cloud Identity and Access Management, infrastructure design, and virtual networking configuration with Virtual Private Cloud(VPC), Projects, Networks, Subnetworks, IP addresses, Routes, and Firewall rules

Google Cloud Infrastructure: Compute Engine, Core Services, customer-supplied encryption keys, security and access management, quotas and billing, and resource monitoring, Scaling and Automation, securely interconnecting networks, load balancing, auto-scaling, infrastructure automation and managed services, Design and Process, define and balance business and technical requirements to design Google Cloud deployments, Kubernetes Engine, Creating and managing software containers and an introduction to the architecture of Kubernetes.

Cloud Computing Standards- Introduction- Objectives, Best Practices and Standards, Practical Issues- Interoperability- Portability- Integration- Security

Reference Books

1. Thomas Erl, Ricardo Puttini, Zaigham Mahmood. *Cloud Computing: Concepts,Technology & Architecture*. Pearson, 2013.
2. Michael J. Kavis. *Architecting the Cloud: Design Decisions for Cloud Computing ServiceModels*. Wiley, 2014.

Reference Online Course

Online Cloud Computing Specialization, Coursera,
https://www.coursera.org/specializations/cloud-computing

Course Title and Code: Software Engineering (CS1113)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech Sem VI
Prerequisites	Programming I, Programming II
Weightage	Theory 50% Practical 50%

Course Objectives: In this course, students will gain a broad understanding of the discipline of software engineering and apply theories, models, and techniques to solve real-world problems.

Learning Outcomes:

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

1. Use software development lifecycle models for project development.
2. Design solutions in various application domains using software engineering approaches that integrate ethical and economic concerns.
3. Elicit and evaluate functional and non-functional requirements for a software system.
4. Design, represent and document software requirements specifications according to IEEE standards.
5. Apply UML modeling for software design.
6. Apply coding standards and guidelines.
7. Prepare code checklist and perform code inspections, code reviews and walkthrough.
8. Develop and implement various manual and automated testing procedures.
9. Estimate the cost of the software project.
10. Evaluate software in terms of software quality and quality assurance according to ISO standards.

Course Syllabus (Theory)

UNIT I: Basics, Software Engineering, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Software Development Life Cycle (SDLC) Models: Waterfall Model, Iterative waterfall model, Incremental Process Model, Evolutionary Development Models, Specialized Process Model, V-Model, An Agile view of the process, Agile process models namely Extreme Programming (XP), Adaptive software development (ASD), Scrum and Crystal.

UNIT II: Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modeling, Data Flow Diagrams, Entity Relationship Diagrams, Decision Tables, SRS Document, IEEE Standards for SRS.

UNIT III: Basic Concept of Software Design, Architectural Design, Low-Level Design, Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design methods and Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design.

UNIT IV: Coding and Software Testing: Coding standards, programming style, code inspection, code review and walkthrough; Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-down and Bottom-up, Testing Strategies, Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products.

UNIT V: Software Measures, Metrics and Models: Various Size Oriented Measures, Hallstead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures, Control Flow Graphs, Software metrics classification, Cost estimation models, Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO); Software quality and quality assurance, ISO standards; Software Re-engineering, Reverse engineering and Software Configuration.

Reference/Text Books:

1. R. S. Pressman, “Software Engineering – A practitioner's approach”, Eighth Edition, McGraw Hill International editions, 2019.
2. Ian Somerville, “Software Engineering”, Tenth Edition, Pearson Education, 2017.
3. Rajib Mall, “Fundamentals of Software Engineering”, Fifth Edition, Prentice-Hall of India Pvt. Ltd., 2018.

Reference Online Courses:

Coursera Courses: 1. Introduction to Software Engineering offered by IBM
2. IBM DevOps and Software Engineering by IBM.

Course Title and Code: Compiler Design (CS1112)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. Sem (VI)
Prerequisites	Programming-I, Data Structures and Algorithms
Weightage	Theory 50%, Practical 50%

Course Objectives- This course aims to familiarize the students with the design of a compiler including its phases and components, develop a compiler.

Learning Outcomes:

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

1. Specify and analyze the lexical, syntactic and semantic structures of programminglanguage features
2. Separate the lexical, syntactic and semantic analysis into meaningful phases for acompiler to undertake language translation
3. Write scanners, parsers, and semantic analyzers without the aid of automaticgenerators
4. Utilize the compiler design concept to write efficient programs
5. Design the structures and support required for compiling advanced languagefeatures.

Course Syllabus (Theory)

UNIT I: Introduction, Lexical analysis: Language processor, compiler, structure of a compiler, applications of Compiler technology, interpreter, cousins of a compiler, introduction to one pass &multipass compilers, Bootstrapping, Review of finite automata, Lexical analyzer, input buffering, Recognition of tokens, Lex: A lexical analyzer generator, Error handling

UNIT II: Syntax analysis: Review of context-free grammars (CFGs), Ambiguity of grammars, Taxonomy for parsing techniques, Top down parsing techniques: non-predictive or backtracking, recursive descent and non-recursive (LL) predictive parsing, bottom up (Shift reduce) parsing techniques: operator precedence parsing, LR (SLR, CLR and LALR) parsers, parsing with ambiguous grammar

UNIT III: Syntax directed definition and Intermediate Code Generation: Syntax-Directed definitions (SDDs): Evaluation order for SDDs; Applications of Syntax-directed translation; Syntax-directed translation schemes**,** Intermediate code generation**:** Variants of syntax trees; Three-address code; Types and declarations; Translation of expressions; Type checking; Control flow; Back patching; Switchstatements; Intermediate code for procedures.

UNIT IV: Run time environments: Storage organization, Stack allocation of space, Access to non-local data on the stack, symbol table organization, Data structures used in symbol tables

UNIT V: Code generation: Basic blocks and Flow graphs, DAG (Directed Acyclic Graph) representation of basic block, Optimization of basic blocks, Issues in design of code generator, The Target language; Addresses in the target code, A simple code generator, Code generation from a DAG

Text Book(s)

1. K. Muneeswaran, Compiler Design, Oxford University Press, 2012

Reference Book(s)

1. Compilers- Principles, Techniques and Tools, Alfred V Aho, Monica S. Lam, RaviSethi, Jeffrey D Ullman – 2nd Edition, Addison-Wesley, 2007.
2. Allen I. Holub “Compiler Design in C”, Prentice Hall of India, 2003.
3. C. N. Fischer and R. J. LeBlanc, “Crafting a compiler with C”, Benjamin Cummings, 2003.

Web Resources

http://nptel.ac.in/courses/106108052/1

Course Title and Code: Cryptography (CS1214)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. Sem VI
Prerequisites	Calculus, Linear Algebra and Differential Equations, Probability and Statistics, Data Structures and Algorithms
Weightage	Theory 40% Practical 60%

Course Objectives-

In this course student will understand cryptographic algorithms and their applications. Throughout the course, students will be exposed to many exciting open problems in the field and work on programmingprojects. This course will help students to explore security aspects of various future courses like, Network Security, Mobile Application Developments and Cloud Computing.

Learning Outcomes:

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

1. Explain the concept of Cryptography
2. Realize the complexities of Cryptographic Attacks
3. Apply the Public-Key Cryptography
4. Learn Symmetric-Key Algorithm
5. Use the techniques of Digital Signatures in their projects
6. Demonstrate the Secure Protocols

I

Course Syllabus(Theory)

- Overview of cryptography. What is a cipher?
- Basic symmetric-key encryption, Stream ciphers, one time pad, Block ciphers, AES and DES. Pseudo Random Permutations (PRP); Pseudo Random Functions (PRF); Chosen plaintext attacks (CPA)
- Message integrity: CBC-MAC and PMAC, Collision resistant hashing, Merkle-Damgard and Davies-Meyer. MACs from collision resistance, SHA and HMAC, Active attacks
- Public key cryptography: Arithmetic modulo primes, Vanilla key exchange (Diffie-Hellman), Public key encryption, ElGamal encryption, RSA and Rabin functions, Trapdoorpermutations
- Digital signatures: Signature using RSA, Hash based signatures, certificates, certificate transparency, certificate revocation.
- Protocols: Identification protocols, Password protocols, salts; one-time passwords, challengeresponse authentication, Zero knowledge proof
- Cryptography in the age of quantum computers, Grover's algorithm and Shor's algorithm

Text Books:

1. Introduction to Modern Cryptography, Katz and Lindell, 3rd Edition.
2. Free book of Cryptography, Dan Boneh and Victor Soup

Reference Courses:

1. Cryptography I, at Coursera by Dan Boneh. https://www.coursera.org/learn/crypto
2. Cryptography, at IITB by M. Prabhakaran https://www.cse.iitb.ac.in/~mp/teach/crypto/

Course Title and Code: Smart Material (ME1228)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. VI Sem
Prerequisites	None
Weightage	Theory 60% Practical 40%

Course Objectives: The objective is to introduce students to the basic concepts of smart materials and composites that are required for their design and fabrication as per the industrial applications.

Learning Outcomes:

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

1. identify various smart materials and its importance in engineering application
2. understand various processing techniques of smart materials
3. identify types of composites for various engineering applications
4. design various application based metal matrix composites

Course Syllabus (Theory):

Unit-1: Introduction to Smart Material

Introduction to smart materials. Classification of smart materials, Components of a smart System, Applications of smart material.

Piezoelectric Materials, Shape Memory Alloys, Shape Memory Polymers, Self-Healing Materials

Unit-2: Processing of Smart Materials

Metals and metallization techniques, Ceramics and their processing, Polymers and their synthesis, UV radiation curing of polymers. Smart material-based MEMS.

Unit-3: Introduction to composite

Define Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Properties of composites in comparison with standard materials. Applications of metal, ceramic and polymer matrix composites.

Stiffness and Strength of composite: volume and weight fraction. Unidirectional continuous fiber, discontinuous fibers, Short fiber systems, woven reinforcements **Mechanical Testing:** Determination of stiffness and strengths of unidirectional composites in tension, compression, and fatigue.

Unit 4: Metal Matrix Composites

Characteristics of MMC, various types of metal matrix composites, alloy vs. MMC, Reinforcements, particles, fibers. Effect of reinforcement volume fraction rule of mixtures. Applications of MMC in aerospace, automotive industries

Processing of MMC: powder metallurgy process, diffusion bonding, stir casting, squeeze casting, a spray process, Liquid infiltration, measurement of interface properties.

Laminates: Lamina Constitutive Equations, basic assumptions of laminated anisotropic plates. Laminate Constitutive Equations, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina properties from Laminate Tests.

Text Books:

1. Smart Material Systems and MEMS: Design and Development Methodologies, V. K. Varadan, K. J. Vinoy, S. Gopalakrishnan, John Wiley and Sons, England, 2006.
2. Smart Structures and Materials, Brain Culshaw, Artech House, London, 1996.
3. Smart Materials and Structures, Mukesh V. Gandhi, Brian S. Thompson, , Springer, May1992
4. Autar K. Kaw, Mechanics of Composite materials, CRC Taylor & Francis, 2nd Ed, 2005.
5. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.

Reference Online Course:

1.Introduction to Composites https://swayam.gov.in/nd1_noc20_me95/preview
2.Smart Materials and Intelligent System Design
https://archive.nptel.ac.in/courses/112/104/112104251/#

Course Title and Code: Fundamental of Sustainable Development (ME1227)	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Students who can take	B.Tech VI Sem
Prerequisites	Basic knowledge of physics and chemistry (Basic Science), Basic knowledge of the Environment
Weightage	Theory 55% Practical 45%

Course Objectives:

The goal of this course is to develop an understanding of the fundamental critical concepts on Sustainable Development (S.D.), such as intra- and inter-generational equity, economic, social and environmental sustainability; strong and weak sustainability; natural capitalism;
steady state and green economy;

Learning Outcomes:

After course completion, the student will be able to:

1. Explain the concept of Sustainable Development and its Role in Building of Environment
2. Identify the critical empirical issues on sustainable development, such as renewable energy transitions, urban agriculture, and green architecture and Analyze the effect of releasing toxicsubstances.
3. Distinguish between "green economy" and "sustainability" and various efforts at multiple governance levels: individual to the government.
4. Make their lives more sustainable and join social movements to achieve more sustainable development.
5. Apply appropriate theoretical knowledge of public policy and international relations to sustainable development.

Course Syllabus (Theory)

Concept of Sustainable Development:

Definition of sustainability; History and the emergence of the concept of sustainable development; Our Common Future; Objectives of Sustainable Development; Millennium Development Goals; Environment and Development linkages; Globalization and Environment; Population, Poverty and Pollution; Global, Regional and Local environmental issues; Resource Degradation; Greenhouse gases and climate Change; Desertification; Industrialization; Social insecurity.

Sustainability and The Triple Bottom Line:

Components of sustainability; Complexity of growth and equity; Social, economic and environmental dimensions of sustainable development; Environment, Biodiversity, Natural Resources; Ecosystem integrity; Clean air and water; Carrying capacity; Equity, Quality of Life, Prevention, Precaution, Preservation and Public participation;Structural and functional linking of developmental dimensions; Sustainability in the national and regional context.

Sustainable Development and International Response:

Role of developed countries in the development of developing countries; International summits; Stockholm to Johanesburg; Rio Principles; Agenda 21, Conventions, Agreements;

Tokyo Declaration; Doubling Statement; Transboundary issues; Integrated approach for resource protection and management.

Sustainable Development of Socio-Economic Systems:

Demographic dynamics of sustainability; Policies for socio-economic development; Strategies for implementing eco-development programmes; Sustainable development through trade; Economic growth; Action plan for implementing sustainable development; Urbanization and Sustainable Cities; Sustainable Energy and Agriculture; Sustainable Livelihoods, and Ecotourism.

Framework for Achieving Sustainability

Sustainability indicators; Hurdles to Sustainability; Operational guidelines; Interconnected prerequisites for sustainable development; Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities, Business and Industry; Science and Technology for sustainable development; Performance indicators of sustainability and Assessment mechanism; Constraints and barriers for sustainable development.

Main References

1. Austin, James and Tomas Kohn. 1990. Strategic Management in Developing Countries.The Free Press.
2. Berger. 1994. "The Environment and the Economy." In Smelser and Swedberg (eds.)he Handbook of Economic Sociology. Russel Sage Foundation. D'Arcy, David. Transcript of broadcast, Dec. 5, 2002, "In Houston, a Treasure of Exiled AfghanArt," National Public Radio.
3. Elkington, John. Cannibals with Forks: The Triple Bottom Line for 21st Century Business Oxford: Capstone Publishing, October 1997.
6. Guillen, Mauro and Sandra L. Suarez. 2002. "The Institutional Context of Multinational Activity." In Organization Theory and the Multinational Corporation. 2nd edition. New York: St. Martin's Press

Online Courses:

1. Driving business towards Sustainable Development Goals (https://www.coursera.org/learn/sdgbusiness)
2. The Sustainable Development Goals – A global, transdisciplinary vision for the future(https://www.coursera.org/learn/global-sustainable-development)
3. Sustainable Cities and Communities Specialization (https://www.coursera.org/specializations/sustainable-cities)
4. Leading Sustainable Community Transformation Specialization (https://www.coursera.org/specializations/sustainabletransformmation) tion

Course Title and Code: Motion Planning, Control, and Manipulation of Robots ME1222	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. VI Semester
Prerequisite:	ME1226 Introduction to Robotics
Weightage:	Theory - 60%, Practical and Projects - 40%
Course Objectives: The course aims to equip the students with basic fundamentals of robotic motion planning and control, and develop control functionality in robots.	
Learning Outcomes: On successful completion of this course, the students shuld be able to: 1 Understand key concepts of robot motion generation. 2 Plan a motion for a robot for different situations including the presence of obstacles. 3 Develop real-time feedback control system and manipulation of the planned motion.	

Course Syllabi (Theory):

Unit I Introduction: Introduction to robot motion planning, Basics of serial robotic arms and mobile robots, Transformations.

Unit II Motion Planning: Motion planning on a discretized C-space grid, C-space obstacles, C-space for mobile robots, C- Space for serial robotic arms, randomized sampling-based planners, Motion planning for multi robotic systems.

Unit III Robot Control: First- and second-order linear error dynamics, stability of a feedback control system, Motion control of robots using joint velocities and/or torques, force control, and hybrid motion-force control.

Unit IV Robot Manipulation: Kinematic constraint, graphical methods for representing kinematic constraints and forces/ torques in the plane, force closure grasping, and examples of manipulation.

Textbooks:

1. K M Lynch and F C Park, Modern Robotics: Mechanics, Planning, and Control, Cambridge University Press (2017).
2. S K Saha, Introduction to Robotics, McGraw Hill Education (India) Private Limited (2014).

Online Courses for Reference:

1. Modern Robotics: Mechanics, Planning, and Control Specialization, 6 course series, Coursera https://www.coursera.org/specializations/modernrobotics.
2. Robot Motion Planning by Prof. Ashish Dutta, IIT Kanpur https://archive.nptel.ac.in/courses/112/104/112104308/.

Course Title and Code: Project in Robotics (ME1223)	
Hours per Week	**L-T-P: 1-0-6**
Credits	**4**
Students who can take	B. Tech. VII Semester
Prerequisite:	ME1226 Introduction to Robotics
Weightage:	Practical and Projects - 100%
Course Objectives: To develop basic robotic system(s) for real-life practical problem and preparing the students to be job ready in the domain of robotics and automation.	
Course Outcomes: On successful completion of this course, the students should be able to: 1 Critically analyze and use/choose suitable hardware components for the project. 2 Develop working model of the robot and control it using software/ remote. 3 Communicate project work among peers and develop soft skills needed in the industry.	

Course Syllabus:

The course is project based. Basic guidelines of conducting the course are provided hereunder:

1. Students will work in team (number of team members in each team will be decided based on the students registered in the course.
2. Each team is expected to come with the novel project idea, discuss and get it approved from the instructor(s), and work on it throughout the course.
3. The projects could be of the following types:
    a. Literature search (LS) type and systematic analysis.
    b. Algorithm development (AD) type and/or implementation.
    c. Design/synthesis (DS) of the final
4. One lecture per week will be taken to explain how to do literature survey, identify and analyze important results, find the software/ hardware (primarily open source) needed to successfully develop the project.
5. Student needs to submit high-quality technical report, a small video (preferably less than 60 seconds), and deliver a presentation of his/her work.

Reference Books:

1. Kevin M. Lynch and Frank C. Park, Modern Robotics Mechanics, Planning, and Control Cambridge University Press (2017).
2. S K Saha, Introduction to Robotics, McGraw Hill Education (India) Private Limited (2014).
3. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).
4. J. J. Craig, Introduction to Robotics: Mechanics and Control, 3rd edition, Addison-Wesley (2003).

Online Courses for Reference:

1. Modern Robotics: Mechanics, Planning, and Control Specialization, 6 course series, Coursera https://www.coursera.org/specializations/modernrobotics.
2. DD National Robocon, IIT Delhi http://www.ddrobocon.in/.
3. Robo-One Workshop, MIT Opencoursware, http://courses.csail.mit.edu/iap/6.095/.

Course Title and Code: Mechanics of Robots (ME1224)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech. VI Semester
Prerequisite:	None
Weightage:	Theory - 60%, Practical and Projects - 40%

Course Objectives: This course is aimed to provide the basic knowledge of kinematics and dynamics of the robotic system(s) essential to devise motion planning and control functionality in robots.

Learning Outcomes:
On successful completion of this course, the students should be able to:

1 Understand basic mathematical concepts to comprehend kinematics and dynamics.

2 Apply concepts of kinematics to develop robotic structure/ framework.

3 Design and develop static/dynamic stable robust robotic system.

Course Syllabi (Theory):

Unit I Mathematical Preliminaries: Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.

Unit II Robot Kinematics: Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg approach, Position representations, Homogeneous transformation matrix, Forward kinematics. Inverse kinematics, Geometric and analytical approach.

Unit III Velocities & Statics: Cross product operator for kinematics, Jacobians - Direct differentiation, Basic Jacobian, Jacobian in a frame, Kinematic singularity, Kinematics redundancy, Force balance equation, Velocity/force duality, Kinematics redundancy, Mechanical design of robot linkages,

Unit IV Robot Dynamics: Introduction to dynamics, Velocity kinematics, Acceleration of rigid body, mass distribution, Newton's equation, Euler's equation, Iterative Newton - Euler's dynamic formulation, Closed dynamic, Lagrangian formulation of manipulator dynamics, Dynamic simulation.

Textbooks:

1. S K Saha, Introduction to Robotics, McGraw Hill Education (India) Private Limited (2014).
2. DK Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019).
3. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006).
4. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).
5. J. J. Craig, Introduction to Robotics: Mechanics and Control, 3rd edition, Addison-Wesley (2003).

Online Courses for Reference:

1. Robotics by Dr. D K Pratihar, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_me56/preview.

Course Title and Code: Flexible Electronics (EE1225)	
Hours per Week	**L-T-P: 3 1 0**
Credits	**4**
Students who can take	B.Tech VI Sem
Prerequisite:	None
Weightage:	Theory 70%, Assignment and Quiz 30%

Course Objectives:

Gain a fundamental understanding of the field of organic and printed electronic materials, fabrication techniques and devices and their potential impact.

1. Learn the fundamentals of flexible and printable electronics and deepen your understanding of them.
2. Develop a grasp of the link between soft matter electronics printing techniques, device performance, and intended applications.
3. Understand the fundamental concepts of device integration on flexible platforms, as well as the benefits and drawbacks of emerging technology that will be employed in future devices.
4. Acquire a basic knowledge of Future Trends in Flexible/Printable Electronics Technology, as well as the commercialization paths for new materials, methods, and tools for printed and flexible electronic systems.

Learning Outcomes:

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

1. Understand the trends and technologies of flexible electronics and its road map.
2. Identify the materials used in the design and manufacturing of flexible electronic devices.
3. Recognize and introduce the various thin-film deposition techniques used in fabrication of Flexible and Printable electronics devices.
4. To provide an understanding of the structure and features of TFT devices.
5. Develop an ability to design a system, component, or process to meet desired needs using novel materials and devices.

Course Syllabus:

1 Motivation for study of organic and printed flexible electronics

2 Materials properties/synthesis of printable semiconductors:
Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, structure and property relationships, paper-based electronics, textile substrates, barrier materials.

3 Thin-film Deposition and Processing Methods for Flexible: Devices CVD, PECVD, PVD, etching, photolithography, low-temperature process integration

4 Introduction: display and lighting technology, solar cells and sensors

5 Organic and Printable Flexible Electronics (Flexible displays technologies, Flat panel lighting technologies, Flexible solar cells and Flexible electronics for RF applications)

6 Thin Film Transistors: Thin Film Thin Film Transistors device structure and performance. Fundamental issues for low-temperature processing, Low temperature thin-film transistor

Devices, Device structures and materials processing, Low-temperature a-Si:H and a-IGZO thin-film transistor device performance, I-V characteristics, device stability.

7 Organic sensors (bio & chemical): Organic material synthesis and Deposition techniques, challenges and road block in fabrication and development of flexible and organic electronics devices.

Reference Books:

Text / Reference book:

1. Wong, William S., Salleo, Alberto, Flexible Electronics: Materials and Application, https://doi.org/10.1007/978-0-387-74363-9.
2. Guozhen Shen and Zhiyong Fan, Editors, Flexible Electronics: From Materials to Devices, MRS Bulletin 41, 818–819 (2016). https://doi.org/10.1557/mrs.2016.227

Related Online Courses for Reference:

1. NPTEL course: Fundamentals Of Electronic Materials And Devices By Prof. Parasuraman Swaminathan | IIT Madras

Course Title and Code: Neuromorphic Engineering (EE1226)	
Hours per Week	**L-T-P: 3 1 0**
Credits	**4**
Students who can take	B.Tech VI sem
Prerequisite:	None
Weightage:	Theory 70%, Assignment and Quiz 30%

Course Objectives:

This course aims to provide an insight of neuromorphic electronic devices, circuits and system design.

1. Learn Ultra-low power computing electronics concepts mimicking computing by biological neurons.
2. Develop a grasp of different Design and simulation techniques of CMOS and nano electronic circuits modelling biological brain.
3. Understand Commercial neuromorphic systems and processors for machine learning applications.
4. Acquire a basic knowledge of Future Trends in neuromorphic engineering Technology, as well as the commercialization paths for new materials, methods, and tools for neuromorphic electronic systems design.

Learning Outcomes:

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

1. Build power-saving hardware devices to analyse real-world noisy data utilizing brain-like mechanisms.
2. Identify and learn basic concepts and current trends in neuromorphic device, circuit, and system design.
3. Design, Develop and Document Analog and Digital neuromorphic systems.
4. Apply neuromorphic systems to develop new VLSI circuits and make report on the same.
5. The students will learn how electronics circuits mimic biological neurons, and will explore their novel variations in these circuits.

Course Syllabus:

1 Introduction to classic neuromorphic circuits. Signalling and operation of Biological neurons, neuron models, signal encoding and statistics; Synapses and plasticity rules, biological neural circuits.

2 MOSFETs for Neuromorphic electronics : FETs - device physics and sub-threshold circuits.

3 Analog and digital electronic neuron design.

4 Programmable Neuromorphic Circuits and Synapses: (Spiking Neural Network, Non-volatile memristive semiconductor devices; Electronic synapse design; Interconnection Networks; Interconnection schemes for large non-spiking and spiking neural networks).

5 Analog and Digital Neuromorphic Circuit and System Design: Analysis of design, architecture and performance characteristics of demonstrated chips employing Analog neuromorphic and Digital neuromorphic VLSI, Electronic synapses and other neuromorphic systems.

Reference Books:

1.Shih-Chii Liu, Jörg Kramer, Giacomo Indiveri, Tobias Delbrück, Rodney Douglas, Analog VLSI: circuits and principles, MIT press, 2002, ISBN 0262122553

2.Carver Mead, Analog VLSI and neural systems, Addison-Wesley, 1989, ISBN0201059924

3.Eric Kandel, James Schwartz, Thomas Jessell, Steven Siegelbaum, A.J. Hudspeth, Principles of neural science, McGraw Hill 2012, ISBN 0071390111

4.Dale Purves, Neuroscience, Sinauer, 2008, ISBN 0878936971

Online Courses for Reference:

1. EE 698P: Memory Technology and Neuromorphic Computing by Prof Shubham Sahay, IIT Kanpur available online at https://www.youtube.com/playlist?list=PLP-rjhz_nIi7vrSb2YyZaLvEMiLC7l26N

Course Title and Code: Digital Logic Verification (EE1227)	
Hours per Week	**L-T-P: 3 0 2**
Credits	**4**
Students who can take	B. Tech. VI Semester
Prerequisite:	Digital Circuit and Systems
Weightage:	Theory 70%, Project 30%

Course Objectives: This course aims to provide knowledge on functional and formal verification models and methodologies used for digital logic. It helps to create test benches using system Verilog and use CAD tools for fault detection.

Learning Outcomes:

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

1Use the partitioning, scheduling, and allocation algorithms to implement high level synthesis to meet space, time, and storage constraints for given behavioral description.

2 Generate input patterns using fault models and perform structural testing of the synthesized RTL.

3 Use YACC tools to generate Control and Data Graphs and perform HLS transformation for VHDL description.

4 Develop Binary Decision Diagrams and deploy equivalence checking and model checking for Sequential Digital Logic Circuits.

Course Syllabus:

1. Introduction to Digital VLSI Design Flow, High level design representation, Scheduling algorithms, Allocation and Binding algorithms.
2. Logic Optimization & Synthesis-Transformations for High Level Synthesis (HLS), Computational Tree Logic, Temporal Logic, Combinational Circuit Test Pattern Generation, Fault Models-Stuck-at-fault, Transistor faults, Bridging faults, Delay faults.
3. Binary Decision Diagram, Implementation using Multiplexer, Fault Tree analysis, Ordered BCD for Sequential Circuits.
4. Verification Techniques-Design Flow, Functional RTL verification, Formal Verification, Models for design verification-Structural network model, State diagrams.

Reference Books:

1. Principles of Functional Verification- Andrew S Meyer, ISBN 13: 978-0750676175.
2. Writing testbenches using System Verilog-Jack Bergeron, ISBN 13: 978-0387292212.

Online Courses for Reference:

1. NPTEL course: Design Verification and Test of Digital VLSI by Dr Santosh Biswas, Dr Jatindra Kumar Deka.

Course Title and Code: Mechanisms for Machines (IL1206)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech Semester-VI(DE)
Prerequisites	None
Weightage	Theory 40% Practical 60%

Course Objectives:

This course aims to build concepts and skills in the design of various mechanisms for machines. The interdisciplinary course includes understanding of sensors for various physical parameters of moving parts/machines. It will aid the domain of Automation courses like Robotics, Machine Vision, Internet of Things, and Industrial Instrumentation and Safety.

Learning Outcomes:

After course completion, the student will be able to:

1. Identify various types of links and pairs for motions in machines
2. Select and use suitable mechanisms to converting one type of motion into Another
3. Select suitable sensors to measure physical parameters.
4. Develop suitable automated mechanism for machine.

Course Syllabus (Theory)

UNIT – I

Introduction to Links and Pairs:

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law. Types of links, pairs and joints. **(10 lectures)**

UNIT - II

Transducer and Actuators:

Physical parameters, Measurement principles, Calibration, Amplification, Mechanical and Electrical Actuators, Closed loop systems for automation. (**10 lectures)**

UNIT – III

Mechanisms for Motion Conversion:

Introduction to four bar chain mechanisms and their inversions for various applications, Introduction to single slider crank chain mechanisms and their inversions for various applications, Introduction to double slider crank chain mechanism and their inversions for various applications. Mechanisms for balancing of ships and aero-planes. **(10 lectures)**

UNIT – IV

Mechanisms for Motion Transmission:

Power transmission through chain, rope and belt drive. Mechanisms for precise and compact power transmission through gears, cam and follower, and lead screws.

Text /Reference Books:

1. Rattan S.S, “Theory of Machines” Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 2nd edition -2005.
2. Sadhu Singh, “Theory of Machines,” Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi, 2ND Edi. 2006.
3. Curtis D Johnson,”Process Control Instrumentation Technology”, PHI, 1986
4. Shigley. J. V. and Uickers, J.J., “Theory of Machines & Mechanisms” OXFORD University press.2004.
5. Theory of Machines, by Thomas Bevan, CBS Publishers and Distributors.
6. Doeblin E.O, “Measurement Systems: Application and Design”, Fourth Edition, McGraw Hill, Newyork, 1992

Course Title and Code: Robotic Process Automation Lab (CS1125)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	BTech (CSE, ECE, CE, ME) Sem VI + BCA Sem IV
Prerequisite	Any Programming Language
Weightage	Quiz 20% Practical 80%
Course Objectives- The course aim is to develop an understanding of Intelligent Automation through Robotic Process Automation for automating business processes using software robots with cost-efficient digital delivery.	
Learning Outcomes: On successful completion of this course, the students should be able to: 1. Use and understand the various functionalities and features of UiPath Studio and Orchestrator. 2. Design, implement, and use RPA activities. 3. Develop basic robots using UiPath Community Edition. 4. Explore various data extraction techniques. 5. Identify processes which can be automated. 6. Develop business BOTs using Automation Anywhere (360). 7. Apply best practices in RPA projects.	

Course Syllabus (Theory):

Unit I: Programming Basic & Recap: Programming concept basic; **Introduction to RPA:** scopes and techniques of automation, RPA components and various RPA platforms, Introduction to UiPath as RPA platform, Applications and Benefits of RPA, Introduction to UiPath Studio, UiPath robot, types of robots, and UiPath Orchestrator. Brief on Studio interface and components.

Unit II: **RPA Projects:** Types of Projects in RPA: Sequence, Flowcharts, and State machines; Variables, Arguments, Data Types and Control flow: flow chart activities and sequences activities. **Data Manipulation:** Text and Data Manipulation**,** Data tables, clipboard management, file operation, importing from and exporting to CSV/Excel file and data table.

Unit III: **Control of Controls:** Attach window activity, Find and wait for the control, Introduction to Recorder, OCR, types of OCR and Screen Scrapping Using OCR. **Selectors:** Selectors, Defining and Assessing Selectors, Customization, Debugging, Dynamic Selectors, Partial Selectors, RPA Challenge.

Unit IV: **Application with Plugins and Extensions:** Mail plugins, PDF plugins, Web integration, excel and word plugins. Extensions- Java, chrome and firefox. **UiPath Advanced Automation concepts and techniques:** Image, Text and introduction of Citrix Automation; **Excel Data Tables & PDF:** Data Tables in RPA, Excel and Data Table basics, Data Manipulation in excel, Extracting Data from PDF, Extracting a single piece of data, Anchors. **Email Automation:** Incoming Email automation, Sending Email automation.

Unit V: **Automation Anywhere (AA):** Overview and Installation of Automation Anywhere Community Edition; Configuration of profile and device credentials; AA Architecture, Flow, List, and Dual Views of projects, Variables and Triggers; and Capstone Projects.

Text Material & Resources:

Text Books:

T1 Tripathi, Alok Mani. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool–UiPath. Packt Publishing Ltd, 2018.

T2 Murdoch, Richard. "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant." Middletown, DE. Omakustanne (2018).

T3 Mahey, H. Robotic Process Automation with Automation Anywhere: Techniques to fuel business productivity and intelligent automation using RPA. Packt Publishing Ltd (2020).

Reference Books:

R1. Abhinav Sabharwal, “Introduction To RPA”, Independently Published Kindle Edition on Amazon Asia-Pacific Holdings Private Limited, 201 8

R2. Gerardus Blokdyk, “RPA Robotic Process Automation”, 5 Star cook, Second Edition, 2018

R3. Kelly Wibbenmeyer, “The Simple Implementation Guide to Robotic Process Automation (RPA): How to Best Implement RPA in an Organization” Paperback, iUniverse, 2018

R4. Willcocks, Leslie P., Mary Lacity, and Andrew Craig. "The IT function and robotic process automation." (2015).

R5. Mullakara, Nandan, and Arun Kumar Asokan. Robotic process automation projects: build real-world RPA solutions using UiPath and automation anywhere. Packt Publishing Ltd, 2020.

Course Title and Code: Google Cloud Lab (CS1223)	
Hours per Week	**L-T-P: 0-0-4**
Credits	**2**
Students who can take	B.Tech. VI Sem
Prerequisite	None
Weightage	Practical 100%

Course Objectives: This course aims to provide hands-on training on Google cloud. The students will learn the Infrastructure and services provided by Google cloud based on well-known practices.

Learning Outcomes:

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

1. Create and deploy resilient, elastic, cost-effective cloud applications on Google Cloud.
2. Examine the trade-offs between deploying applications in Google Cloud and over the local Infrastructure.
3. Deploy applications over commercial cloud computing infrastructures, i.e., Google Cloud.
4. Evaluate the performance, scalability, and availability of the underlying cloud
5. technologies and software.

Course Contents:

Getting Started with Compute Engine, Getting Started with Cloud Marketplace, Getting Started with Cloud Storage and Cloud SQL, Getting Started with GKE, Getting Started with App Engine, Getting Started with Deployment Manager and Cloud Monitoring

Getting Started with BigQuery, Working with the Cloud Console and Cloud Shell, Infrastructure Preview, VPC Networking. Implement Private Google Access and Cloud NAT

Creating virtual machines, Working with Virtual Machines, Cloud IAM, Cloud Storage, Implementing Cloud SQL, Examining Billing Data with BigQuery, Resource Monitoring, Error Reporting, and Debugging

Virtual Private Networks (VPN), Configuring an HTTP Load Balancer with Autoscaling, Configuring an Internal Load Balancer, Automating the Infrastructure of networks using Terraform, Building a DevOps Pipeline, Deploying Apps to Google Cloud, Monitoring Applications in Google Cloud

Text Books:

1. Google Cloud Associate Examination Workbook, Google Cloud 2022
2. Thomas Erl, Ricardo Puttini, Zaigham Mahmood. Cloud Computing: Concepts, Technology & Architecture. Pearson, 2013.
3. Michael J. Kavis. Architecting the Cloud: Design Decisions for Cloud Computing Service Models. Wiley, 2014.

Course Title and Code: Project (PR1107)	
Credits	**4**
Students who can take	B.Tech Sem VII
Prerequisites	None
Weightage	Report and Project 100%

Course Objectives- This course offers an opportunity to apply and extend knowledge learned throughout the program to solve real world issues. The projects undertaken span a diverse range of topics, including design, simulation, and experimental studies. The course emphasizes, facilitating student learning in technical, project implementation and presentation spheres.

Learning Outcomes:

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

1. Identify and formulate industrial and societal problems.
2. Design engineering solutions for complex problems.
3. Develop/fabricate, and implement solutions for identified problem.
4. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Course Title and Code: Computer Vision (CS1228)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B.Tech. VII Sem and BCA 5th Sem
Prerequisites	Programming I, Linear Algebra and Differential Equations, Probability and Statistics, Machine Learning, Deep Learning
Evaluation	Theory 55%, Lab 45%

Course Objective: This course introduces the fundamental concepts of image and video-based features and how to use them for training ML/DL models for recognition tasks. It will cover object detection, segmentation, convolutional network model construction and training pipeline for image/video-based recognition applications. The course will also discuss the end-to-end development of state-of-the-art machine learning and deep learning models used in computer vision. This course will provide a hands-on state-of-the-art experience with tools and libraries used for building a vision pipeline.

Course Outcomes:

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

1. Understand the fundamentals of Image Processing, Computer Vision and its applications.
2. Learn about the major vision tasks (detection, recognition, segmentation and tracking) along with their evaluation methodology.
3. Learn about state-of-the-art deep learning models for solving the major vision tasks applied for images and videos.
4. Learn the tools and techniques for implementing the core functionality of a computer vision system.
5. Identify the domain-specific requirements and build custom image/video processing learning based models and pipeline.

Course Syllabus (Theory):

UNIT-I: *Introduction to Image Processing and Computer Vision*: Image Formation, Digital Camera, Image data representation, Color Spaces, Filtering, Histogram Equalization, Fourier Transforms, Pyramids, Wavelets, Edge Detection, Image Features.

UNIT-II: *Convolutional Neural Networks (CNN) - Features and Applications:* CNN architectures for Classification, and Detection tasks (AlexNet, VGG, ResNet, FasterRCNN, MaskRCNN, YOLO). Video action classification features and models (Two-stream, 3DCNNs).

UNIT-III: *Spatial Features and working with video data:* Low level image features - SIFT, HOG, LBP. Face/Pedestrian/Object Detection, Video data representation, RGBD, background modeling / subtraction, MBH, BoVW based model training. Semantic Segmentation.

UNIT-IV: *Motion understanding:* Optical Flow, Shot Boundary Detection, detection and tracking in videos, Trajectory extraction (iDTs), trajectory clustering, FlowNet, SLAM.

UNIT-V: *Benchmark Datasets and Video Action Recognition:* Large-scale datasets, ActivityNet, Kinetics, AVA, TRECVid. Transformer Models, ViT, PixelCNN, Self-supervised learning on videos. Generative models. Applications of Action Recognition. Eigen Faces.

Reference Books:

1. Richard Szeliski – 'Computer Vision'.

2. Computer Vision: A Modern Approach, David A. Forsyth and Jean Ponce, Pearson 2nd Edition.
3. Deep Learning – Ian Goodfellow.
4. CVPR/ICCV/ECCV/BMVC conference and journal papers.
5. PyTorch and OpenCV tutorials.

Reference Online Course:

Computer Vision - CAP5415 UC CRCV
https://www.youtube.com/playlist?list=PLd3hlSJsX_IkXSinyREhlMjFvpNfpazfN

Computer Vision and Image Processing – IIT Guwahati NPTEL
https://www.youtube.com/playlist?list=PLwdnzlV3ogoVsma5GmBSsgJM6gHv1QoAo

Computer Vision (Univ of Washington)
https://courses.cs.washington.edu/courses/cse455/22sp/

Computer Vision (Univ of Washington - Shapiro)
https://courses.cs.washington.edu/courses/cse576/22sp/

NYU Deep Learning 2021: Alfredo and Yann LeCun
https://www.youtube.com/playlist?list=PLLHTzKZzVU9e6xUfG10TkTWApKSZCzuBI

Course Title and Code: Fundamentals of Investing (FA1127)	
Hours per Week	**L-T-P: 4-0-0**
Credits	**4**
Students who can take	B. Tech Semester-VII Elective
Pre-requisite	None
Weightage	Theory 70% Practical 30%

Course Objective:

The income that a person receives may be used for purchasing goods and services that he currently requires or it may be saved for purchasing goods and services that he may require in the future. In other words, income can be what is spent for current consumption. savings are generated when a person or organization abstain from present consumption for a future use. The person saving a part of his income tries to find a short term or long term investment avenues for his savings until they are required to finance his future expenditure, this result in investment.

The course is primarily designed for novice investors who want to better understand the concept of investing and investment decision making. This course will cover different investment vehicles, Time value of money and power of compounding, balancing risk and return, project valuation and the capital budgeting process, financial services and institutions.

Course Outcomes:

After course completion, the student will be able to:

1. Comprehend the fundamentals of investment and different investment vehicles.
2. Evaluate and Explore the effects of investments on personal finances
3. Apply the concept of Time value of money to your personal finance and retirement planning.
4. Analyze viability of different projects for investment decision making.
5. Comprehend the role of financial markets and intermediaries and financial services.

Course Syllabus (Theory):

Module-I Investment Environment

The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets (Equity, Mutual funds, Debt), Introducing investment tools- Deposits, Bonds, saving schemes such as PF, PPF, NPS, SSY, NSC, Post office saving schemes, Insurance- Term, Endowment plans, Gold, SGBs etc.

Module-II Time Value of Money and balancing Risk and Return

Fundamental Valuation Concept- Time value of Money: Concept and Rationale, Compounding and Discounting of cash flows. FV & PV of Annuity, Risk & Return Trade.

Module-III Project Valuation and capital budgeting process

Capital Budgeting: Capital budgeting process, Non-Discounting cash flow techniques, Discounting cash flow techniques, Accept Reject Rules.

Module IV: Introducing Financial Markets and Institutions: The Indian securities market, the market participants (Stock exchanges, Stock brokers, Clearing House, Depositories, Depository Participants, FIIs, Domestic institutional investors, Individual investors), Online and offline trading in securities, security market indices, sources of financial information.

Course Title and Code: Operations Research (AS1201)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech Semester-VII **Elective**
Pre-requisite	**None**
Evaluation	Theory – 70%, Lab – 30%

Course Objective:

This Course aims to develop various concepts and tools to help students understand operations research and mathematical modeling methods. To introduce the students to the advanced methods for large-scale decision analysis, supply chain management, and reliability problems.

Course Outcomes: After course completion, the student will be able to:

1 Determining the characteristics of different types of decision-making environments and the appropriate decision-making approaches and tools to be used in each type.

2 Formulate and translate a real-world problem, given in words, into a mathematical formulation.

3 Use these tools to analyze strategic, tactical, and operational supply chain decisions including facility location, vehicle routing, and inventory management.

4 Improve decision-making by identity minimize trouble spots by identifying the critical factors.

5 Find reliability and operation analysis which includes system reliability analysis, failure investigation and corrective action.

6 Know how to work in a team, specifically to solve larger problems, communicate technical knowledge, partition a problem into smaller tasks, and complete tasks on time.

Course Syllabus (Theory)

Decision Analysis

Introduction to OR, Introduction to Decision Analysis, A Prototype Example, Decision Making without Experimentation, Decision Making with Experimentation, Decision Trees.

Markov Chain

Introduction to Markov Chain, Stochastic Processes, Chapman-Kolmogorov Equations, Classification of States of Markov Chain.

Supply Chain Analysis and Inventory Management

Introduction, Introduction to Supply Chain Management and Supply Chain Strategy, Supply Chain Performance Metrics and Drivers Objectives of Inventory Control, Types of Inventories.

Network Optimization Models

The Terminology of Networks, Shortest-Path Problem, Minimum Spanning Tree Problem, and Project Management with CPM/PERT.

Reliability Theory

Introduction, System Reliability, Failure Rates, Bath-tub, Reliability of Systems, Practical Utility of Reliability Evaluation.

Text and References Books:

1. Hillier F.S. and Lieberman G.J., Introduction to Operations Research: Concepts and Cases, Tata McGraw Hill, 8th Ed., 2010 Ed. TMH.
2. Kasana H.S. and Kumar K.D., Introductory Operations Research: Theory and Applications, Springer.
3. Srinivasan, G., Operations Research: Principles And Applications. PHI Learning Pvt. Ltd, 2007.
4. Taha. H. A, Operations Research: An Introduction, Pearson Education, 7th ed., 2017.
5. Ackoff, R.L. and Sasini, M. W., Fundamentals of Operations Research, Wiley & Sons, New York.
6. Waddington, C. H., O. R. in World War 2: Operational Research Against the U-boat, London, Elek Science, 1973.

Recommended MOOC:
https://www.coursera.org/specializations/supply-chain-management#courses

Course Title and Code: Behavioral Assessments for Employability (BS1105)	
Hours per Week	**L-T-P: 4-0-0**
Credits	**4**
Students who can take	B. Tech Semester-VII Elective
Pre-requisite	None
Weightage	Presentations 20% Assignments 40% Reports 30% Participation 10%

Course Objectives: This course aims to enhance student's self-awareness, and to expand their capacity of self -management and development. Human Behavior is manifestation of certain innate and learned competencies. These competencies encompass intelligence, knowledge, skills, attitudes and actions. Right behaviors are precondition for excellence in other competencies. Further technical knowledge and skill can be taught vis-a- vis behavioral competencies are consciously developed through self-awareness. It immerses them to understand the key behavior and attitude assessed by the employer in job market and makes them undergo various psychological test. By the end of the course students will be able to develop their psychological assessment profile and identify their strength. This would enable their personal growth and help them project right behavior and attitude while seeking employment

Course Outcomes:

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

1. Create awareness about different types of psychological tests in vogue.
2. Provide a theoretical background for supplementing the understanding of psychological assessment.
3. Learn to interpret test profiles and explore patterns in interpretation from several tests.
4. Explore and identify their core personal strengths and values.
5. Identify and expand their capacity of development

Topics :

- Theory and Issues in Psychological Testing
- Intelligence Testing - Theoretical Background
- Aptitude Testing - The D.A.T.
- Personality Assessment - Theoretical Background
- Self-Report Inventories
- Assertiveness Test
- Stress Assessment
- Ego states & life positions
- Growth mindset
- Ethics assessment
- Typological Tests
- Projective Techniques
- Integration of Profiles

Course Title and Code: Solid and E-Waste Management (AS1210)	
Hours per Week	**L-T-P: 3-1-0**
Credits	4
Students who can take	Open Elective
Pre-requisite	None
Weightage	Theory 55% Practical 45%

Course Objective: This course provides an in-depth understanding of solid and hazardous waste characteristics and management. This course will also discuss the overall scenario of E-Waste management. This imparts life skills about E-waste management in routine daily life to minimize the different wastes and apply effective management throughout society.

Course Outcomes:

After course completion, the student will be able to:

1. Analyze key sources, typical quantities generated, composition, and properties of solid and hazardous wastes.
2. Compare effective methods of solid & hazardous waste handling and segregation of wastes at source.
3. Test the most common techniques for preventing, minimizing, recycling, disposing, and treatment of solid and e-waste and their application in on-site remediation.
4. Recognize the important regulations which are applied for the effective management of solid and E-wastes.
5. Use engineering methods to identify, formulate, and solve waste problems.

Course Syllabus (Theory):

INTRODUCTION: Types and Sources of solid wastes and E-waste- Indian and global scenario of the - Need for solid and E-waste management – Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, E-waste generation in India, Composition of E-waste, Possible hazardous substances present in E-waste, Environmental and Health implications.

WASTE LEGISLATION: Legislations on management and handling of solid waste. The regulatory regime for e-waste in India, the hazardous waste (Management and Handling) rules 2003, E-waste management rules 2015, Regulatory compliance including roles and responsibilities of different stakeholders – producer, manufacturer, consumer, etc., Proposed reduction in the use of hazardous substances (RoHS), Extended producer responsibility (EPR).

WASTE PROCESSING & TECHNOLOGY: Composition - Hazardous Characteristics –Source reduction of wastes – Recycling and reuse. Handling and segregation of wastes at source – storage and collection of solid & E-wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations - labeling and handling of hazardous wastes. Processing technologies – thermal conversion technologies - energy recovery – incineration. Life cycle assessment of a product (LCA) method, Emerging recycling, and recovery technologies

DISPOSAL: Guidelines for environmentally sound management of e-waste, environmentally sound treatment technology for e-waste, Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills, leachate, and landfill gas management. Case studies, and unique initiatives from around the world. Case study -Optimal planning for computer waste.

Text Book:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, McGraw- Hill, New York, 1993
2. Johri R., “E-waste: implications, regulations, and management in India and current global best practices”, TERI Press, New Delhi

REFERENCE BOOKS:

Refer to all courses related books, other than textbooks here.

1. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.
2. George Tchobanoglous; Frank Kreith Handbook of Solid Waste Management, Second Edition ISBN: 9780071356237 Publication Date & Copyright: 2002.The McGraw-Hill Companies, Inc
3. Thomas H. Christensen; Solid Waste Technology & Management, 1 & 2; First published:23 November 2010 Print ISBN:9781405175173 |
4. NPTL course IIT Kharagpur. (https://nptel.ac.in/courses/105105169)

Course Title and Code: **Disaster Management (CE 1206)**	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Students who can take	B. Tech Sem VI (OE)
Prerequisite	None
Weightage	Theory 50% Practical 50%

Course Objective: This course aims to develop understanding of various natural and manmade disasters. Natural disasters include earthquake, Tsunami, Flood, forest fires and Land Slides. Manmade disasters include fire, Industrial Pollution, embankment failure, structural failure and due to electric supply. Topics includes the causes for these disasters and remedial measures which can minimize the losses to the life and property. The course also includes the identification and description of electric supply resilience and restoration.

Course Outcomes

On completion of the course, the student should be able to:

1. Asses the types of disasters, causes and their impacts.
2. Assess vulnerability and various methods of risk reduction measures and mitigation.
3. Draw the hazard and vulnerability profile of a given region.
4. Analyze the impact of Storms and Severe Weather on electric utility.
5. Plan and execute framework to black start and restoration procedure with considering security criteria and power system reliability.

Course Syllabus (Theory)

Unit-1 Introduction to Disasters, Various types of disaster, Natural: Flood, Earthquake, cyclone, Land slide, Manmade: Fire, Industrial Pollution, embankment failure, structural failure, Loss of resources.

Unit-2

Risk and Vulnerability:

Risk: Its concept and analysis, Risk reduction, Vulnerability: Its concept and analysis, strategic development for vulnerability reduction

Unit 3

Disaster Management in Electrical Systems:

Causes of Extended Outages, System Impact of the Loss of Major Components, Methods to Reduce Energy System Vulnerability, Development of an On-Site and Off-site Disaster management Plan, Accident prevention techniques and Reporting procedures, Investigation reports, Impacts of Blackouts.

Unit – 4

Management- Objectives, Processes, Events, analysis, base-line data, forecasting and Warnings. Disaster preparedness plan concept and nature, Emergency operation center and IT aids- physical environment, Applications. Public-private agency co-ordination- federal, state and local disaster response organization and network, Citizen and community role in disaster response and recovery.

Text /Reference Books:

1. M. Pandey, “Disaster Management” Wiley India Pvt. Ltd.
2. Tushar Bhattacharya, “Disaster Science and Management” McGraw Hill Education (India) Pvt. Ltd.
3. Crisis and disaster management plan for power sector by central electricity authority of India

4. N. Malla, S. Poudel, N. R. Karki and N. Gyawali, "Resilience of electrical power delivery system in response to natural disasters," 2017 7th International Conference on Power Systems (ICPS), Pune, 2017, pp. 806-811.doi: 10.1109/ICPES.2017.8387400
5. Sahni, Pardeepet. al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall of India, New Delhi.

Course Title and Code: Practice School – II (PS-2), PS1102	
Total Duration	**4-4.5 months**
Credits	**16**
Students who can take	B.Tech Semester-VIII
Prerequisites	None
Weightage	Practical 100%

Course Objective:

The aim of this course is to expose students to the real-world industrial environment to acquire knowledge of various professional skills, working of industry, and interaction with the people. Practice school-II is essential to inculcate confidence and encourage to take-up professions/entrepreneurship to serve the society in general

Course Outcomes:

On successful completion of Practice school-II, the students be able to:

1. Apply skills and engineering knowledge to identify various Industrial problems.
2. Analyze and solve engineering related problems in industry using methods, tools and techniques learnt at the university.
3. Demonstrate ethic and professionalism in engineering practice.
4. Communicate effectively with the technical community and produce effective reports and presentations

Course Title and Course Code: Entrepreneurial Project (PR1105)	
Duration	**16 weeks**
Credits	**16**
Students who can take	B. Tech Semester-VIII
Prerequisites	None
Weightage	Practical 100%

Course Objectives:

The aim of this course is to expose students to the entrepreneurship in computer science. The students are expected to identify new business opportunities in the technology sector, innovate and create a solution and finally implement Business strategy.

Course Outcomes:

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

1. Apply skills and knowledge to identify new entrepreneurial opportunities
2. Analyze the market and competitors around the identified opportunity
3. Innovate, Design and Create the specific product or solution
4. Develop a business model for the entire solution

Course Title and Course Code: Research Project (PR1104)	
Duration	**16 weeks**
Credits	**16**
Students who can take	B. Tech Semester-VIII
Prerequisites	None
Weightage	Practical 100%

Course Objectives:

The aim of this course is to expose students to the research conducted in computer science. The students are expected to identify, formulate and solve a research problem.

Course Outcomes:

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

1. Apply skills and knowledge to identify research problems.
2. Analyze the related work around the identified research problem.
3. Design efficient solutions to solve the identified problem.
4. Evaluate, test and compare the methodology used to solve the problem.

Course Title and Code: Optimization for Computer Science (AS1113)	
Hours per Week	**L-T-P: 3-0-2**
Credits	**4**
Students who can take	B. Tech IV Sem (CSE/CS+AI)
Evaluation	Theory – 70%, Lab – 30%

Course Objective: Optimization problems are prevalent in numerous fields, including machine learning, reinforcement learning, signal processing, and networks. This course develops into the fundamental principles of continuous optimization and provides a comprehensive overview of unconstrained and constrained optimization problems.

Course Outcomes:

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

1. formulate real-world problems as mathematical optimization problems.
2. analyze and choose appropriate optimization methods for specific problem domains.
3. implement and use optimization algorithms, such as gradient descent and evolutionary methods,
4. Recognize the computational complexity of optimization problems and strategies for handling large-scale instances.

Course Syllabus (Theory):

Introduction to Optimization

Overview of optimization problems and their types (continuous, discrete, constrained, unconstrained). Formulation of optimization problems (objective functions, decision variables, constraints). Local vs. global optimization.

Nonlinear programming

Convex sets and convex functions, their properties, convex programming problem, generalized convexity, Pseudo and Quasi convex functions, KKT conditions.

Search Techniques

Direct search and gradient methods, Unimodal functions, Fibonacci method, Golden Section method, Method of steepest descent, Newton-Raphson method, Conjugate gradient methods.

Dynamic Programming

Characteristics of Dynamic Programming Problems, Deterministic and Probabilistic Dynamic Programming.

Nature Inspired Algorithms

Genetic Algorithms, Binary and Real coded Genetic Algorithms, Coding and decoding of variables, Key steps in a GA, starting population, fitness evaluation, reproduction, crossover, mutation, evaluation.

Text and Reference Books:

1. S S Rao, Engineering Optimization: Theory and Practices, New Age International, 1996.
2. Hillier F.S. and Lieberman G.J., Introduction to Operations Research: Concepts and Cases, Tata McGraw Hill, 8th Ed., (Indian Adapted Edition), 2005.
3. Taha. H. A, Operations Research: An Introduction, Pearson Education, 7th ed., 2003.
4. Bazaaraa, Hanif D. Shirali and M.C.Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley & Sons, New York (2004).
5. Boyd and L. Vandenberghe, Convex Optimization, The Cambridge University Press, 2003.
6. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, PHI.

Course Title and Code: Linear Algebra and Differential Equations (AS1114)	
Hours per Week	**L-T-P: 3-1-0**
Credits	**4**
Pre-requisite	**None**
Students who can take	B. Tech II Sem
Evaluation	Theory – 100%

Course Objective: The primary objective of the course is to develop a good understanding of fundamental concepts of linear algebra and ordinary differential equations (ODE). This includes learning analytic and numerical methods for solving ODEs, and system of linear equations.

Learning Outcomes:

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

1. model complex systems as linear simultaneous equations and analyze the same using matrix methods.
2. model data as matrices, find eigenvalues and eigenvectors and apply the same for solving problems.
3. solve a range of ODEs, including first-order ODEs and higher-order linear ODEs.
4. apply numerical methods, such as Euler's method, and Runge-Kutta methods to approximate solutions of ODEs.
5. apply the knowledge of ODEs to model and solve real world problems in various scientific and engineering disciplines.

Course Syllabus (Theory):

Linear Algebra

Matrix Operations, Eliminations, Inverse of a matrix, Solution of the system of linear equations, Rank of a matrix, Consistency, Vector Spaces and Subspaces, Spanning sets and linear independence, Bases and Dimension, Linear Transformation, Kernel and range of a linear map, Rank and Nullity Theorem, Eigenvalues and Eigenvectors, Characteristic and minimal polynomial, Cayley Hamilton theorem and applications, Diagonalization of matrices.

Ordinary Differential Equations

Introduction to DE, Order and degree of DE, First Order ODE: Direction fields, Separable form, Exact equations, Integrating factors, Linear differential equations. Numerical methods: Euler's method, Modified Euler's method, Runge-Kutta method, Second and higher order linear ODE with constant coefficients, non-homogeneous linear equations with constant coefficients, Euler and Cauchy's equations, Method of variation of parameters, System of linear differential equations.

Text and Reference Books:

1. Advanced Engineering Mathematics, Erwin Kreysig, 9th edition, John Wiley & Sons, 2005.
2. A Friendly Introduction to Numerical Analysis, Brain Bradie, Pearson, 2006.
3. Advanced Engineering Mathematics, Wylie and Barrett, 6th edition, McGraw Hill, 2003.
4. Numerical Analysis, Richard L. Burden and J. Douglas Faires, 9th edition, Brooks/Cole, Cengage Learning, 2011.
5. Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyenger, R. K. Jain, 5th edition, New Age International Limited Publishers, 2007.