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Assessment plan for Integrated Work

Kalvium Program Scheme

The scheme details courses under 4 different cores.

1. **Foundation -** A set of courses designed taking a liberal approach to help students develop crucial 21st-century skills.
2. **Skilling -** Courses oriented toward software engineering-readiness, that start with basic programming eventually lead to high-level product development.
3. **Academic -** Courses designed to inculcate strong foundational knowledge in computer science, these courses are thoughtfully crafted to impart the concepts, their applications, and practical labs associated with them.
4. **Integrated Work -** Relevant (paid) work experience in global tech companies where students gain real-world application development expertise, workplace exposure, and industry-ready skills.

Semester 1

Core	Course Name	Credits
Skilling	Front-end web development	4
Foundation	Critical thinking 101	4
Academic	Discrete Mathematics	4
Foundation	Professional skills for the workplace	3
Academic	The breadth of computer science 1	4
Skilling	Problem solving using programming	4
Academic	Design for developers	3
		26

Semester 2

Core	Course Name	Credits
Foundation	Learning how to learn	4
Academic	The breadth of computer science 2	4
Skilling	Full Stack Web Development	12
		20

Semester 3

Core	Course Name	Credits
Foundation	Economics, Politics and Rural Society Development	3
Foundation	Mathematical thinking 101	4
Academic	Database Management Systems	5
Academic	Object Oriented Programming	4
Integrated Work	Integrated work with a partner company	8
		24

Semester 4

Core	Course Name	Credits
Foundation	How human languages work?	4
Foundation	Tools and techniques for creative thinking	4
Academic	Operating Systems	4
Academic	Data Structure and Algorithms	4
Integrated Work	Integrated work with a partner company	8
		24

Semester 5

Core	Course Name	Credits
Foundation	English LSRW	3
Foundation	Principles of Science	4
Academic	Computer Organization & Architecture	4
Academic	Formal Language & Automata Theory	4
Academic	Design & Analysis of Algorithms	3
Integrated Work	Integrated work with a partner company	8
		26

Semester 6

Core	Course Name	Credits
Foundation	Discovering Self	3
Foundation	Fundamentals of Business Management	3
Academic	Compiler Design	4
Academic	Computer Networks	4
Integrated Work	Integrated work with a partner company	8
		22

Semester 7

Core	Course Name	Credits
Foundation	Introduction to philosophy	3
Foundation	Foundation Elective	3
Academic	Academic Elective #1	4
Academic	Academic Elective #2	4
Integrated Work	Integrated work with a partner company	8
		22

Semester 8

Core	Course Name	Credits
Skilling	Skilling Elective	4
Integrated Work	Integrated work with a partner company	16
		20

Assessment model

At Kalvium, we strongly believe in the effectiveness of **continuous evaluation/ assessment** as a way to improve learning outcomes and ensure students are retaining knowledge over time. Research has shown that frequent assessments, such as quizzes and assignments/ projects, can help reinforce learning and improve long-term retention (Roediger III and Karpicke, 2006). Furthermore, continuous evaluation allows for timely feedback and opportunities for students to address any areas where they may be struggling, resulting in better overall performance (Freeman et al., 2014).

That's why, at Kalvium, we have implemented a continuous evaluation model for all of our courses that includes regular assessments and projects throughout the semester. This approach enables us to better support our students' learning and ensure they are well-prepared for future challenges.

You will see this practically executed as each course having anywhere between 3-6 continuous assessments spread through the duration of the course, with each assessment carrying a specific weightage. The details of those are covered in the *Assessment plan* section under Detailed Course Syllabus and Assessment Plan.

Detailed Course Syllabus & Assessment Plan

Semester 1

Front-end web development

Introduction

In this course, students will learn the fundamentals of front-end web development, including HTML, CSS, JavaScript, and React JS. They will learn how to create responsive and dynamic web pages, as well as develop their problem-solving and critical thinking skills. The course will focus on hands-on projects and exercises to give students practical experience in front-end web development.

Course outcomes

At the end of this course, students will be able:

1. To develop proficiency in HTML, CSS, and JavaScript, and apply them to the development of interactive and responsive web pages.
2. To design and implement web pages that are accessible, user-friendly, and optimized for search engines.
3. To create and use reusable code components to improve productivity and maintainability.
4. To demonstrate an understanding of the principles of web design and user experience, and apply them to front-end development.
5. To use debugging tools and techniques to identify and fix errors in web applications.
6. To work collaboratively and effectively in a team environment on web development projects.

Syllabus

Unit 1 HTML, CSS & JS first steps
Environment set up, Introduction to HTML, HTML Block Elements, HTML Inline Elements, HTML Forms, Introduction to CSS, CSS Font & Text, CSS Selectors, CSS Inheritance, CSS Colors, Box Model, Flex Box, JS DOM, Introduction to JS, JS Variables, JS Data Types, Basics of JS Operators, Basics of JS Strings, Basics of JS Conditional Statements, Basics of JS Control Statements, Basics of JS Arrays, Basics of JS Functions, Basics of JS Objects

Unit 2 – HTML, CSS & JS Deep dive Part 1
CSS Advanced Selectors, CSS Positioning, Advanced Flexbox, CSS Grids, Responsive Design, JS Operators, JS Strings, JS Conditional Statements, JS Control Statements, JS Arrays & Functions, JS Objects

Unit 3 HTML, CSS & JS Deep dive Part 2
JS Advanced Functions, JS Nested Data Structures, JS Higher Order Functions, JS Event Handling, Object Oriented JS, JS Closure, JS Storage, CSS Transition, CSS Animation

Unit 4 JS the hard parts
JS Prototypal Inheritance, JS Async, JS Callbacks, JS Promises, JS APIs, JS Axios, Unit testing in JS, Deployment

Unit 5 React first steps
Environment set up, Introduction to React, Props & State, Components, React App using Babel, Rendering lists of data, JSX, Hooks, Additional Hooks, Event Handling, Component Lifecycle, Class based components, Routing

Unit 6 React deep dive
React Forms, Fetching Data from API, Redux, React Redux, Redux Toolkit, React CSS Library, Material-ui

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Project-based	20
Continuous assessment - 2	Project-based	20
Continuous assessment - 3	Project-based	20
Continuous assessment - 4	Project-based	20
Continuous assessment - 5	Project-based	20

Text book(s)

1. Web development: This book includes: Web development for Beginners in HTML + Web design with CSS + Javascript basics for Beginners; Andy Vickler; Ladoo Publishing LLC (24 May 2021)
2. The Road to Learn React: Your Journey to Master Plain Yet Pragmatic React.Js; Robin Wieruch; Zaccheus Entertainment (1 January 2018)

Reference book(s)

1. HTML, CSS, and JavaScript All in One; Julie C. Meloni & Jennifer Kyrnin; Pearson Education; Third edition
2. React and React Native: A complete hands-on guide to modern web and mobile development with React.js; Adam Boduch & Roy Derks; Packt Publishing Limited; 3rd edition

Critical thinking 101

Introduction

Critical Thinking is a course designed to introduce students to the concepts of reasoning and decision-making, and to the cognitive biases and heuristics that can impede accurate and rational thinking. Based on the seminal book "Thinking, Fast and Slow" by Daniel Kahneman, the course will equip students with the skills to recognize and avoid common thinking errors, and to think more critically and effectively.

Course outcomes

At the end of this course, the students will be able:

1. To describe the cognitive biases and heuristics that can affect human reasoning, and explain how they can lead to thinking errors.
2. To recognize and identify common thinking errors and fallacies in everyday situations.
3. To apply critical thinking skills to analyze and evaluate arguments and evidence.
4. To synthesize ideas and perspectives from different sources to develop reasoned and well-supported arguments.
5. To evaluate the reliability and validity of different sources of information and evidence.
6. To communicate critical thinking ideas and solutions clearly and effectively, both orally and in writing.

Syllabus

Unit 1 – The two systems of thinking
Why think critically, The two systems of thinking, The mental power unit, The lazy system, The marvels of priming, Cognitive ease, Norms, surprises and ease, How judgements work, Jumping to conclusions

Unit 2 – Heuristics and biases
The law of small numbers, Anchoring effect, Availability bias, Representativeness bias, Conjunction fallacy, Survivorship bias, Sunk cost fallacy, Confirmation bias, Google effect and other common biases

Unit 3 – Critical thinking in action
Assignments on identifying biases in the news, creating fake news, writing an unbiased review, alien travel guide, facts vs opinion, worst case scenarios, hypothetical scenarios

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Subjective assessment using case studies	20

Continuous assessment - 2	Subjective assessment using case studies	20
Continuous assessment - 3	Multiple-choice test	20
Continuous assessment - 4	Multiple-choice test	20
Continuous assessment - 5	Multiple-choice test	20

Text book(s)

Thinking, Fast and Slow; Daniel Kahneman; Penguin 2012 edition

Reference book(s)

Critical Thinking; Jonathan Haber; The MIT Press; Illustrated edition (7 April 2020)

Discrete Mathematics

Introduction

Discrete Mathematics is a foundational course for computer science students that introduces the mathematical concepts and techniques essential to computer science. The course covers topics such as logic, sets, functions, relations, combinatorics, graph theory, and number theory. It emphasizes problem-solving, critical thinking, and effective communication of mathematical ideas. Discrete Mathematics provides the mathematical foundation for further study in algorithms, data structures,and other areas of computer science.

Course outcomes

At the end of this course, the students will be able:

1. To explain the fundamental concepts and principles of discrete mathematics, including logic, sets, functions, and relations.
2. To apply discrete mathematics concepts to solve problems in computer science.
3. To analyze and evaluate the correctness and efficiency of algorithms, and the validity and soundness of logical arguments.
4. To synthesize discrete mathematics concepts to create mathematical models for real-world problems, such as scheduling and network optimization.
5. To evaluate the strengths and limitations of various discrete mathematics techniques, and make informed decisions about which approach to use in a given context.
6. To communicate mathematical ideas and solutions clearly and effectively, both orally and in writing.

Syllabus

Unit 1 Proofs
Introduction and Proofs, Induction, Strong Induction, Number Theory

Unit 2 Structures
Graph theory and Colouring, Matching Problems, Minimum Spanning Tree, Communication Networks, Directed graphs, Relations and partial orders, State machines

Unit 3 Counting - Part 1
Sums, asymptotics, Divide and Conquer Recurrences, Linear Recurrences

Unit 4 Counting - Part 2
Counting Rules, Generating functions, Infinite sets

Unit 5 Probability Part 1
Introduction to Probability, Conditional Probability, Independence, Random variables

Unit 6 Probability Part 2
Expectations, Deviations, Random Walks

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Multiple-choice	20
Continuous assessment - 2	Multiple-choice	20
Continuous assessment - 3	Multiple-choice	20
Continuous assessment - 4	Multiple-choice	20
Continuous assessment - 5	Multiple-choice	20

Text book(s)

Mathematics for Computer Science; Eric Lehman, F Thomson Leighton, Albert R Meyer; 12th Media Services (5 June 2017)

Reference book(s)

1. Discrete Mathematics and Its Application; Kenneth H Rosen & Dr Kamala Krithivasan; McGraw Hill; 8th edition
2. A Textbook on Discrete Mathematics; CV Sastry and Rakesh Nayak; Wiley (1 October 2020)

Professional skills for the workplace

Introduction

Professional Skills for the Workplace is a course designed to help students develop the human skills they need to succeed in the modern workplace. The course is based on the Human Skills Matrix, developed by MIT JWEL, and covers four key quadrants: thinking, leading, interacting, and managing oneself. Students will learn practical strategies for improving their communication, collaboration, problem-solving, and self-management skills.

Course outcomes

At the end of this course, students will be able:

1. To explain the four quadrants of the Human Skills Matrix and how they relate to success in the workplace.
2. To apply critical thinking skills to solve complex problems and make effective decisions.
3. To lead and collaborate effectively with others, including managing teams and facilitating group discussions.
4. To communicate clearly and persuasively in various professional contexts, including written, verbal, and nonverbal communication.
5. To manage time and prioritize tasks effectively, including setting goals and developing strategies for self-motivation and self-improvement.
6. To synthesize different human skills and apply them to real-world workplace challenges, such as conflict resolution, innovation, and project management.

Syllabus

Unit 1 – Managing ourselves
Self-awareness, Adaptability, Managing emotions, Accountability, Professionalism, Taking initiative, Persistence, Planning and organizing, Integrity

Unit 2 – Interacting
Writing good emails & reports, Use of communication tools, Use of project management tools, Curating relationships on social media through professional networking sites, Negotiation skills, Presentation skills

Univ 3 – Thinking
Ethical dilemmas, being an intrapreneur, Building a growth mindset, Systems thinking

Unit 4 – Leading
Empowering others, Having a strategic vision, Project management, Performance management

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Subjective assessment using case studies	20
Continuous assessment - 2	Subjective assessment using case studies	20
Continuous assessment - 3	Multiple-choice test	20
Continuous assessment - 4	Multiple-choice test	20
Continuous assessment - 5	Multiple-choice test	20

Text book(s)

COMMUNICATION SKILLS FOR PROFESSIONALS AND STUDENTS: An Occupational Therapist's Perspective; Dr. Amitabh Kishor Dwivedi; Notion Press; 1st edition

Reference book(s)

The Communication Book: 44 Ideas for Better Conversations Every Day; Mikael Krogerus & Roman Tschäppeler; Portfolio Penguin (19 April 2018)

The breadth of computer science 1

Introduction

This course provides students with a unique opportunity to build a modern computer system from scratch. The course will let students start with Nand gates, build their way up to a fully functioning computer with an operating system, and gain a deep understanding of how computers work.

Course outcomes

At the end of this course, students will be able:

1. To demonstrate knowledge of basic computer architecture principles.
2. To work with Boolean algebra and logic design.
3. To implement basic combinational and sequential circuits.
4. To write assembly language programs to control hardware components.
5. To design and implement a fully functional computer system.
6. To evaluate the trade-offs involved in different hardware and software design choices.

Syllabus

Unit 1: Boolean Logic and Digital Design

Introduction to digital systems and digital logic, Boolean algebra and logic gates, Combinational logic circuits, Sequential logic circuits, Building elementary logic gates using Nand gates

Unit 2: Boolean Arithmetic and the CPU

Arithmetic logic unit (ALU), Half adder and full adder, Ripple carry adder, Multi-bit addition, Multi-bit ALU,
CPU components (registers, instruction memory, data memory)

Unit 3: Memory and Machine Language
Random-access memory (RAM), Memory maps, Machine language, Assembly language, The HACK computer architecture, Implementation of a simple computer using the HACK architecture

Unit 4: Computer Architecture
The von Neumann architecture, Memory hierarchy, Input/output (I/O), Operating system (OS) basics,
Hardware-software interface, Building an assembler to translate assembly code into machine code,

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Multiple-choice test	20
Continuous assessment - 2	Multiple-choice test	20
Continuous assessment - 3	Multiple-choice test	20
Continuous assessment - 4	Multiple-choice test	20
Continuous assessment - 5	Multiple-choice test	20

Text book(s)

The Elements of Computing Systems: Building a Modern Computer from First Principles by Noam Nisan and Shimon Schocken, published by MIT Press. Latest edition: 2nd edition (August 2019).

Reference book(s)

1. Computer Organization and Design: The Hardware/Software Interface by David A. Patterson and John L. Hennessy, published by Elsevier. Latest edition: 5th edition (October 2013).

2. Digital Design and Computer Architecture by David Money Harris and Sarah L. Harris, published by Morgan Kaufmann. Latest edition: 3rd edition (June 2021).

Problem solving using programming

Introduction

Problem Solving using Programming is an introductory course that teaches fundamental programming concepts and techniques using C++ and Python. After learning this course, students will easily be able to learn more programming languages and use this course for practicing. The course emphasizes problem-solving skills and computational thinking, and equips students with the skills necessary to tackle real-world problems using programming.

Course outcomes

At the end of this course, the students will be able:

1. To explain fundamental programming concepts, including data types, control structures, and functions.
2. To apply programming constructs to solve simple problems and algorithms in C++ and Python.
3. To analyze and evaluate the efficiency and correctness of algorithms and programs.
4. To synthesize programming constructs to develop larger programs that solve complex problems.
5. To evaluate the strengths and weaknesses of different programming constructs and choose appropriate solutions for different problems.
6. To communicate programming solutions clearly and effectively, both orally and in writing.

Syllabus

Unit 1 Algorithms
Computational thinking, Decomposition, Abstraction, Pattern recognition, Algorithms, Writing pseudocode and translating it to code, Looping (While and do-while loops), Variables (Scope, lifetime and initialization), Datatypes (Structures, classes, enums)

Unit 2 Variables
Review of variables and their uses, including how to declare and initialize variables; Arithmetic operators, Relational operators, Logical operators, Bitwise operators & Assignment operators; Introduction to strings and advanced string manipulation techniques, such as concatenation, substring extraction, searching, and replacing; Introduction to characters including ASCII and Unicode encoding, character classification functions, and character mapping; Typecasting; Using constants to represent fixed values in code; local and global variables, and their uses and limitations; operator precedence, order of evaluation, and short-circuiting

Unit 3 Control basics

If, If else, for loop & while loop; using boolean expressions to control program flow and evaluate conditions; using switch statements to select one of many possible code paths based on a value or condition; advanced topics such as nested loops, loops with multiple variables, and using loops to iterate

Unit 4 Control advanced
Nested if, Nested if elseif, Else, for loop, while loop in arrays and strings; Exception handling; using recursive functions to solve problems that can be broken down into smaller sub-problems; advanced techniques for using loops, such as using loop counters, loop flags, and sentinel values; using advanced branching techniques such as the ternary operator and conditional expressions

Unit 5 Modularity
Organizing code into modules, classes, and functions to improve code structure and reusability; Function parameters; Function return value; reviewing recursion and its use in function design and implementation; Libraries and APIs

Unit 6 Program development
Game development using a programming language, debugging, basic game design principles, user interface design, performance optimization

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Coding test	20
Continuous assessment - 2	Coding test	20
Continuous assessment - 3	Coding test	20
Continuous assessment - 4	Coding test	20
Continuous assessment - 5	Coding test	20

Text book(s)

Think Like a Programmer: An Introduction to Creative Problem Solving by V. Anton Spraul, Released August 2012, published by No Starch Press

Reference book(s)

1. Programming in Python 3: A Complete Introduction to the Python Language; Mark Summerfield; Pearson Education; Second edition
2. C++ Programming Language; Bjarne Stroustrup; Pearson Education; 4th edition

Design for developers

Introduction

Design for Developers is a course designed to introduce students to the fundamental principles of user interface (UI) and user experience (UX) design, with a focus on the needs of developers. The course covers topics such as visual design, user-centered design, usability testing, and accessibility, and provides hands-on experience with design tools and techniques.

Course outcomes

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

1. To explain the basic principles of user-centered design, and how they apply to software development.
2. To evaluate and critique the design of existing software applications, and identify areas for improvement in terms of user experience and usability.
3. To apply visual design principles and techniques, such as typography, color theory, and layout, to create effective user interfaces.
4. To conduct usability testing and other evaluation methods to measure the effectiveness and usability of software applications.
5. To synthesize different design concepts and techniques to create well-designed and user-friendly software interfaces.
6. To evaluate the accessibility of software applications and understand the importance of designing for users with diverse needs.

Syllabus

Unit 1 How to approach design as a developer
Why design for developers, Getting started with design education, Getting started with Figma, Labs on Figma

Unit 2 UX Design for Developers
Understanding design sprints, Understanding the user, Information architecture, Accessibility in design, How to build good digital products, Psychology in UX design, User research, User journey mapping, Wireframing, Prototyping

Unit 3 UI Design for Developers
Visual design principles, Visual hierarchy, Working with text, Layouts and spacing, Working with colours, Working with images, Creating depth in design, Working with components

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Case-study analysis	20

Continuous assessment - 2	Project-based	40
Continuous assessment - 3	Project-based	40

Text book(s)

About Face; Alan Cooper, Robert Reimann, Christopher Noessel and David Cronin; Wiley Publishing, 2014

Reference book(s)

1. Hands-on UX design for developers; Elvis Canziba; Packt, 2018
2. Refactoring; Adam Wathan and Steve Shoger

Semester 2

Learning how to learn

Introduction

Learning How to Learn is a course designed to help students master the concepts and techniques of effective learning, with a focus on online and remote learning environments. The course covers topics such as the science of learning, memory techniques, metacognition, and overcoming procrastination, and provides practical strategies for improving learning outcomes in any subject area.

Course outcomes

At the end of this course, students will be able:

1. To explain the key principles and processes involved in effective learning, and how they can be applied to any subject area.
2. To apply a variety of memory techniques, such as spaced repetition and visualization, to improve retention and recall of information.
3. To practice metacognitive strategies, such as self-reflection and self-assessment, to monitor and improve learning progress.
4. To identify and overcome common obstacles to effective learning, such as procrastination and distractions.
5. To synthesize different learning techniques and apply them to real-world learning challenges, such as preparing for exams or learning new skills.
6. To evaluate the effectiveness of different learning strategies and make evidence-based decisions about the best approach for a given learning situation.

Syllabus

Unit I: How learning works
Introduction to Focus and Diffuse Modes, the role of Practice in learning, Introduction to Memory & Sleep in learning, Procrastination on learning, case studies to end the unit (on learning languages, creativity, problem solving and much more – how learning happens for these skills)

Unit II: Chunking
Introduction to Chunking, how to form a Chunk, Illusions of Competence, the pitfalls of overlearning & choking

Unit III: Procrastination, Memory and Learning
Avoiding rut thinking, strategies and techniques to tackle procrastination while learning, Process vs. Product, Deep-dive into memory, Long-term memory, Being a life-long learner, The Memory Palace technique

Unit IV: Being a better learner
Creating Visual metaphors, creating analogies for learning, Importance of checklists, Learning vs. Prepping for tests, Case studies

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Multiple-choice test	20
Continuous assessment - 2	Multiple-choice test	20
Continuous assessment - 3	Multiple-choice test	20
Continuous assessment - 4	Multiple-choice test	20
Continuous assessment - 5	Multiple-choice test	20

Text book(s)

1. Learning How to Learn: How to Succeed in School Without Spending All Your Time Studying; A Guide for Kids and Teens; Barbara Oakley and Terrence Sejnowski; Tarcher Perigree 2018
2. Make it Stick: The Science of Successful Learning; Peter C Brown, Henry L. Roediger III & Mark A. McDaniel; Harvard University Press; 1st edition

Reference book(s)

1. Mindshift: Break Through Obstacles to Learning and Discover Your Hidden Potential; Barbara Oakley, Penguin, 2017

2. How we learn: The surprising truth about when, where and why it happens; Benedict Carey, Random House, 2014
3. Ultralearning: Accelerate Your Career, Master Hard Skills and Outsmart the Competition; Scott H Young, Harper Collins, 2019

The breadth of computer science 2

Introduction

In this course, students will continue the journey of building a modern computer system from first principles. Starting with the CPU, they will design and implement an assembler, a compiler, and an operating system. By the end of the course, students will have built a complete, fully functional computer system.

Course outcomes

At the end of this course, students will be able:

1. To design and implement a simple CPU.
2. To write an assembler to translate assembly language code into machine code.
3. To write a compiler to translate high-level language code into assembly language code.
4. To design and implement a simple operating system.
5. To analyze and optimize the performance of software and hardware components.
6. To collaborate with a team to build a complete, functional computer system.

Syllabus

Unit 1: Virtual Machine I: Stack Arithmetic
Introduction to virtual machines (VMs); Stack operations and the stack architecture, Stack arithmetic;
Memory segments: local, argument, this, that; Program flow control; Function calling conventions

Unit 2: Virtual Machine II: Program Control
Program flow control, Labeling commands and program flow control, Conditional and unconditional branching, Function calling and return, Implementing function calls using VM operations, Recursive function calling

Unit 3: High-Level Language and Compiler I: Syntax and Parsing
Overview of high-level programming languages, Language grammar and syntax, Formal language theory,
Parsing and its various techniques, Top-down and bottom-up parsing, Implementation of a Jack compiler

Unit 4: High-Level Language and Compiler II: Code Generation and Optimization
Code generation and its challenges, Compilation of expressions, statements and control structures, Memory management, Symbol table management, Intermediate representations, Optimizations and their techniques

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Multiple-choice test	20
Continuous assessment - 2	Multiple-choice test	20
Continuous assessment - 3	Multiple-choice test	20
Continuous assessment - 4	Multiple-choice test	20
Continuous assessment - 5	Multiple-choice test	20

Text book(s)

The Elements of Computing Systems: Building a Modern Computer from First Principles by Noam Nisan and Shimon Schocken, published by MIT Press. Latest edition: 2nd edition (August 2019).

Reference book(s)

1. Computer Architecture: A Quantitative Approach by John L. Hennessy and David A. Patterson, published by Elsevier. Latest edition: 6th edition (June 2021).
2. Compilers: Principles, Techniques, and Tools by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, published by Pearson. Latest edition: 2nd edition (September 2006).

Back-end Web Development

Introduction

This course provides a comprehensive introduction to back-end web development, focusing on building scalable and secure server-side applications. Students will learn how to use Node.js and Express to create dynamic web services and APIs. The course covers database management, server optimization, and integration with front-end technologies.

Course outcomes

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

1. Explain the fundamental concepts of server-side programming and the role of backend in web development.
2. Develop server-side applications using Node.js and Express.
3. Compare different database management systems and their use in back-end development.

4. Assess and optimize the performance of server-side applications.
5. Design and implement secure and scalable back-end solutions.
6. Integrate back-end services with front-end applications in a full-stack environment.

Syllabus

Unit 1: Introduction to Back-end Development
Fundamentals of server-side programming, Role of back-end in web development, Introduction to Node.js, Setting up a Node.js environment, Basics of JavaScript for back-end development

Unit 2: Working with Express.js
Introduction to Express.js, Routing in Express, Middleware in Express, Building RESTful APIs, Handling requests and responses

Unit 3: Database Management
Introduction to databases, SQL vs NoSQL databases, Working with MongoDB, Mongoose ORM, CRUD operations in MongoDB

Unit 4: Security and Authentication
Security best practices in web development, User authentication and authorization, Implementing JWT-based authentication, Protecting routes and data, Secure communication with HTTPS

Unit 5: Performance and Scalability
Performance optimization techniques, Caching strategies, Load balancing and clustering, Handling concurrent requests, Scaling applications

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	MCQ/ Subjective/ Coding	20
Continuous assessment - 2	MCQ/ Subjective/ Coding	20
Continuous assessment - 3	MCQ/ Subjective/ Coding	20
Continuous assessment - 4	MCQ/ Subjective/ Coding	20
Continuous assessment - 5	MCQ/ Subjective/ Coding	20

Text book(s)

Beginning Node.js, Express & MongoDB Development; Greg Lim; Published by Greg Lim; 2020 edition

Reference book(s)

Learning Node.js Development: Learn the fundamentals of Node.js, and deploy and test Node.js applications on the web; Andrew Mead; Packt Publishing; 2018 edition

Databases

Introduction

This course covers the essential concepts of database systems, focusing on NoSQL databases, Redis, and vector databases. Students will learn to design, implement, and manage non-relational databases, using technologies like MongoDB, Cassandra, Redis, and emerging vector databases.

Course outcomes

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

1. Describe the fundamental concepts of NoSQL databases and their differences from traditional relational databases.
2. Explain the architecture and data models used in MongoDB and other NoSQL databases.
3. Develop basic CRUD operations and queries using MongoDB.
4. Analyze use cases to determine the suitability of NoSQL databases over relational databases for specific scenarios.
5. Assess the performance and scalability of MongoDB in various application contexts.
6. Design and implement a complete application using MongoDB, incorporating advanced features such as indexing, aggregation, and replication.

Syllabus

Unit 1: Introduction to NoSQL Databases
Overview of NoSQL databases, Types of NoSQL databases: Key-Value, Document, Column-Family, Graph, Comparison with relational databases, Use cases and applications

Unit 2: MongoDB Basics
Introduction to MongoDB, Installation and setup, MongoDB architecture, Data models: documents, collections, and databases

Unit 3: CRUD Operations in MongoDB
Creating databases and collections, Inserting, updating, and deleting documents, Querying documents using MongoDB query language, Working with BSON

Unit 4: Indexing and Aggregation
Understanding indexing in MongoDB, Creating and managing indexes, Aggregation framework: pipelines, stages, and operators, Examples of aggregation queries

Unit 5: Advanced MongoDB Features
Data replication and sharding, Transactions in MongoDB, MongoDB Atlas and cloud services, Security and authentication

Unit 6: Performance and Scalability
Performance tuning techniques, Monitoring and profiling MongoDB, Scaling MongoDB applications, Case studies and real-world examples

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	MCQ/ Subjective/ Coding	20
Continuous assessment - 2	MCQ/ Subjective/ Coding	20
Continuous assessment - 3	MCQ/ Subjective/ Coding	20
Continuous assessment - 4	MCQ/ Subjective/ Coding	20
Continuous assessment - 5	MCQ/ Subjective/ Coding	20

Text book(s)

NoSQL with MongoDB in 24 Hours, Sams Teach Yourself; Brad Dayley; Pearson Publication; 2015 edition

Reference book(s)

1. NoSQL: Database for Storage and Retrieval of Data in Cloud; Ganesh Chandra Deka; CRC Press; 2017 edition
2. Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems; Martin Kleppmann; Shroff/O'Reilly; 2017 edition

Full Stack Web Development

Introduction

Full Stack Web Development is a course designed to teach students how to build dynamic web applications using the MERN stack (MongoDB, Express, React, and Node.js). The course covers both backend and database development, as well as front-end technologies like HTML, CSS, and JavaScript. By the end of the course, students will have built their own unique full stack application, which they can showcase in their portfolio.

Course outcomes

At the end of this course, students will be able:

1. To describe the architecture and components of a full stack web application, including front-end and back-end technologies and their interactions.
2. To design and develop a database schema using MongoDB, including defining data models, creating indexes, and writing queries.
3. To create RESTful APIs using Node.js and Express, including handling HTTP requests and responses, and interacting with the database.
4. To implement front-end user interfaces using React, including using React components, managing state, and handling user input.
5. To integrate front-end and back-end components to create a fully functional full stack web application, including using asynchronous communication and handling errors and exceptions.
6. To design and implement a unique full stack application as a capstone project, including identifying user requirements, developing a software design, and implementing and testing the application.

Syllabus

Unit 1: Introduction to Full Stack Web Development
Overview of full stack web development, the MERN stack and its components, setting up the development environment (using tools like Node.js, MongoDB, and VSCode), basic backend development concepts (e.g., routing, handling requests, working with databases)

Unit 2: Backend Development and Databases
Designing and implementing a database schema using MongoDB, writing basic queries and data manipulation commands, creating a RESTful API using Node.js and Express, handling HTTP requests and responses, interacting with the database using Mongoose

Unit 3: Front-end Development with React
Overview of React and its components, creating and managing React components, working with state and props, handling user input and events, styling with CSS and Bootstrap

Unit 4: Software Engineering and Project Management
Introduction to Software Engineering and SDLC, Agile and Scrum methodologies, software project management tools (like JIRA/ Trello/ GitHub), version control with Git

Unit 5: Integrating Front-end and Back-end Components
Asynchronous communication between front-end and back-end, handling errors and exceptions, using middleware to process requests, authentication and authorization with JWT

Unit 6: Building a project
Design and development of a unique full stack application, identifying user requirements and developing a software design, implementing and testing the application, deployment on cloud platforms like AWS, Heroku or Netlify

Assessment plan

The grading of this course is based on the students' progress in building their capstone project. Each capstone is divided into 5 different milestones (this would vary from project to project, since each would be unique).

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Project milestone #1 evaluation (Design and Front-end)	20
Continuous assessment - 2	Project milestone #2 evaluation (Back-end and Databases part 1)	20
Continuous assessment - 3	Project milestone #3 evaluation (Back-end and Databases part 2)	20
Continuous assessment - 4	Project milestone #4 evaluation (Full Stack)	20
Continuous assessment - 5	Project milestone #5 evaluation (Deployment and final review)	20

Text book(s)

Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js; Shama Hoque; Packt Publishing Limited; 2nd edition

Reference book(s)

1. Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js App; Greg Lim
2. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node; Vasan Subramanian; Apress; 2nd edition

Semester 3

Economics, Politics and Rural Society Development

Introduction

This course is designed to provide CS engineers with an understanding of basic economics, politics, and rural development and how these three fields are interconnected. Students will learn about the principles of economics, the functioning of political systems, and the challenges and opportunities in rural development. Through this course, students will develop a multidisciplinary perspective, enabling them to identify and contribute to solutions that benefit both society and the economy.

Course outcomes

At the end of this course, students will be able:

1. To demonstrate an understanding of basic economic principles and their applications to real-world scenarios.
2. To analyze political systems and the role of technology in modern political processes.
3. To evaluate the challenges and opportunities in rural development, with a focus on the role of technology.
4. To apply economic and political principles to rural development scenarios.
5. To develop critical thinking skills to identify and solve complex problems related to economics, politics, and rural development.
6. To communicate effectively with stakeholders from different backgrounds and perspectives, including policymakers, entrepreneurs, and rural communities.

Syllabus

Unit 1: Introduction to Economics
Basic concepts of economics, including demand, supply, and market equilibrium; Macroeconomic concepts, such as GDP, inflation, and unemployment; Economic policies, such as fiscal and monetary policies; Applications of economics in the technology industry.

Unit 2: Political Systems and Processes
Understanding of the functioning of political systems, such as democracy, authoritarianism, and socialism; The role of technology in modern political processes, including social media and big data analytics; Political policies and their impact on the economy and society.

Unit 3: Rural Development
Definition and characteristics of rural areas; Challenges and opportunities in rural development, including poverty, health, and education; Role of technology in rural development, including e-governance, e-commerce, and digital literacy; Policies and initiatives for rural development.

Unit 4: Interdisciplinary Perspectives and Case Studies

Interdisciplinary approach to solving complex problems related to economics, politics, and rural development; Case studies of successful rural development initiatives that integrate technology, economics, and politics.

Assessment plan

Assessment component	Details of the assessment	Additional details, if any	Weightage
Continuous assessment - 1	Multiple-choice test on unit 1	A short quiz to test the basic concepts learned in Unit 1, including demand, supply, and market equilibrium, and macroeconomic concepts such as GDP, inflation, and unemployment.	25
Continuous assessment - 2	Political analysis	Students will choose a political system (democracy, authoritarianism, socialism, etc.) and analyze how it affects the economy and society. Students will be asked to analyze political policies and their impact on the economy and society and provide a writeup followed by a viva.	25
Continuous assessment - 3	Rural development proposal	Students will develop a proposal for a rural development initiative that integrates technology, economics, and politics. The proposal should address challenges and opportunities, role of technology, and policies and initiatives for rural development.	25
Continuous assessment - 4	Case study analysis	Students will analyze a real-world case study related to rural development and write a report on the challenges and opportunities, role of technology, and policies and initiatives for rural development.	25

Text book(s)

1. Economics: Principles, Problems, and Policies by Campbell McConnell, Stanley Brue, and Sean Flynn. (Latest edition, published by McGraw-Hill Education India)
2. Politics: An Introduction by Andrew Heywood. (Latest edition, published by Palgrave Macmillan India)
3. Rural Development: Principles, Policies and Management by B. P. Vani and K. Sivaramane. (Latest edition, published by SAGE Publications India Pvt Ltd)

Reference book(s)

1. Rural Development: Putting the last first; Robert Chambers; Pearson Education India; 2nd Edition (2010)
2. Economic Development of Rural Areas: An Analysis of Problems and Prospects; L. P. Singh; Sage Publications India Pvt Ltd; 2nd Edition (2011)

Mathematical thinking 101

Introduction

This course is designed to provide CS Engineers with a foundation in basic mathematical concepts relevant to aptitude tests and problem-solving in the tech industry. Students will learn topics such as number systems, ratios, proportions, averages, profit and loss, time and work, time, speed and distance, permutations, percentages, simple and compound interest, statistics, and geometry.

Course outcomes

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

1. To apply mathematical concepts to solve problems encountered in aptitude tests and the tech industry
2. To use mathematical methods to evaluate data and make informed decisions
3. To analyze and interpret statistical data
4. To understand the basic principles of geometry
5. To demonstrate proficiency in mental math and calculation
6. To identify the relationships between different mathematical concepts and apply them to problem-solving.

Syllabus

Unit 1: Speed Math
Mental calculation techniques for addition, subtraction, multiplication, and division; Approximation techniques for finding the nearest answer quickly; Tricks for working with squares, cubes, and square roots

Unit 2: Number System
Conversion between number systems: decimal, binary, octal, and hexadecimal
Basic arithmetic operations in different number systems
Applications of number systems in computer science

Unit 3: Ratios, Proportions, Mixtures and Alligations
Concepts of ratios and proportions; Mixtures and Alligations concepts

Unit 4: Profit, Loss, Mixtures and Alligations

Understanding profit and loss in business context; Applications of profit, loss, partnerships; Mixtures and Alligations problem-solving

Unit 4: Time and Work
Concepts of time and work; Work efficiency and work-days formulas; Applications of time and work in problem-solving

Unit 5: Time, Speed and Distance
Concepts of time, speed, and distance; Different formulas and their applications; Relative speed concept

Unit 6: Permutation
Concepts of permutation; Circular permutations and permutations with restrictions; Applications of permutation in problem-solving

Unit 7: Percentages, SI and CI
Concepts of percentage, simple interest, and compound interest; Different formulas and their applications;
Installments and recurring deposits

Unit 8: Statistics
Basic concepts of statistics: mean, median, mode, variance, and standard deviation; Data presentation: pie chart, bar chart, and line graph; Applications of statistics in problem-solving

Unit 9: Geometry
Basic concepts of geometry: points, lines, angles, and triangles; Pythagorean theorem and trigonometry
Applications of geometry in problem-solving

Assessment plan

Assessment component	Details of the assessment	Weightage
Continuous assessment - 1	Multiple-choice test	20
Continuous assessment - 2	Multiple-choice test	20
Continuous assessment - 3	Multiple-choice test	20
Continuous assessment - 4	Multiple-choice test	20
Continuous assessment - 5	Multiple-choice test	20

Text book(s)

Quantitative Aptitude for Competitive Examinations; R.S. Aggarwal; S. Chand Publishing; 2021

Reference book(s)

1. How to Prepare for Quantitative Aptitude for CAT; Arun Sharma; McGraw Hill Education; 2022
2. The Pearson Guide to Quantitative Aptitude for Competitive Examinations; Dinesh Khattar; Pearson Education; 2021

Database Management Systems

Introduction

This course is designed to teach students the fundamental concepts and principles of Database Management Systems (DBMS) and how to effectively design, implement, and manage databases. Students will learn various database models and acquire hands-on experience in using popular DBMS tools.

Course outcomes

At the end of this course, students will be able:

1. To understand the fundamental concepts of database management systems including data models, data normalization, and database design.
2. To be able to design and implement a relational database using SQL.
3. To be able to use a popular DBMS tool such as MySQL to create and manage databases.
4. To be able to use SQL to query and manipulate data stored in a database.
5. To be able to apply database management concepts to real-world scenarios and problem-solving.
6. To be able to design and implement a functional database-driven web application.

Syllabus

Unit I – Introduction to DBMS
The Evolution of Database Systems- Overview of a Database Management System-Outline of DatabaseSystem Studies-The Entity-Relationship Data Model: Elements of the E/R Model-Design Principles-The Modeling of Constraints-Weak Entity Sets.

Unit II – The Relational data model and Algebra
Basics of the Relational Model-From E/R Diagrams to Relational Designs-Converting Subclass Structures to Relations-Functional Dependencies-Rules About Functional Dependencies-Design of Relational Database Schemas – Multi valued Dependencies-Relational Algebra: Relational operations-Extended Operators of Relational Algebra-Constraints on Relations.

Unit III – SQL
Simple Queries in SQL-Sub queries-Full-Relation Operations-Database Modifications-Defining a Relation Schema-View Definitions- Constraints and Triggers: Keys and Foreign Keys-Constraints on Attributes and Tuples-Modification of Constraints-Schema-Level Constraints and Triggers -Java Database ConnectivitySecurity and User Authorization in SQL

Unit IV – Index structures and query processing
Index Structures:Indexes on Sequential Files-Secondary Indexes-B-Trees-Hash Tables-Bitmap Indexes-Query Execution: Physical-Query-Plan Operators-One-Pass , two-pass & index based Algorithms, Buffer Management, Parallel Algorithms-Estimating the Cost of Operations-Cost-Based Plan Selection -Order for Joins-Physical-Query-Plan

Unit V – Failure recovery and concurrency control
Issues and Models for Resilient Operation -Undo/Redo Logging-Protecting against Media FailuresConcurrency Control: Serial and Serializable Schedules-Conflict-Serializability-Enforcing Serializability by Locks-Locking Systems With Several Lock Modes-Concurrency Control by Timestamps, validation transaction management: Serializability and Recoverability-View Serializability-Resolving DeadlocksDistributed Databases: commit& lock.

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Project-based	Design and implement a simple database schema for a given scenario	20
Continuous assessment - 2	Project-based	Implement a more complex database schema and write queries to retrieve data from the database	20
Continuous assessment - 3	Project-based	Design and implement a database security and administration plan for a given scenario	20
Continuous assessment - 4	Project-based	Apply database concepts to a real-world scenario and implement a complete database solution	20
Continuous assessment - 5	Project-based	Optimize a database schema and write efficient queries for a given data set.	20

Text book(s)

Database Systems: Models, Languages, Design And Application Programming By Ramez Elmasri, Shamkant B. Navathe, Pearson 6th edition

Object Oriented Programming

Introduction

This course teaches the principles of Object-Oriented Programming (OOP), which is a key concept in modern programming paradigms. The course is language-agnostic, but students can choose to implement their projects in either C++ or Python.

Course outcomes

At the end of this course, students will be able:

1. To explain the fundamental concepts and principles of OOP, such as encapsulation, inheritance, and polymorphism.
2. To apply OOP concepts to develop software applications in C++ and Python.
3. To design and implement complex data structures and algorithms using OOP concepts.
4. To develop and manage large-scale software projects using OOP design patterns and software engineering practices.
5. To analyze and evaluate the performance and efficiency of OOP-based programs.
6. To collaborate and communicate effectively in a team environment to develop and maintain OOP-based software projects.

Syllabus

Unit 1 Introduction to Object-Oriented Programming
Basics of OOP, Objects and Classes, Abstraction, Encapsulation, Inheritance, Polymorphism, Procedural Programming vs OOP

Unit 2 Advanced Concepts in OOP
Templates, Overloading, Exception Handling, Operator Overloading, Inheritance and Polymorphism, Advanced Topics in Inheritance

Unit 3 Object-Oriented Design Principles
SOLID Principles, Design Patterns, Design for Reuse, Design for Testability.

Unit 4 Software Engineering Practices
Agile Development, Waterfall Model, Software Development Life Cycle (SDLC), Version Control, Code Reviews, Testing and Debugging.

Unit 5

Advanced Topics in OOP Multithreading, Concurrency, Networking, GUI Programming, Database Programming, Best Practices for OOP

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Coding test, online	Coding test on basic object-oriented concepts (e.g., classes, objects, inheritance, polymorphism)	20
Continuous assessment - 2	Coding test, online	Coding test on advanced object-oriented concepts (e.g., interfaces, abstract classes, design patterns)	20
Continuous assessment - 3	Project-based	Project-based coding assignment where students design and implement an object-oriented program that solves a specific problem	20
Continuous assessment - 4	Coding test, online	Coding test on object-oriented design principles (e.g., SOLID principles, cohesion and coupling, design patterns)	20
Continuous assessment - 5	Project-based	Project-based coding assignment where students design and implement a larger-scale object-oriented program.	20

Text book(s)

1. Object-Oriented Programming with C++; E Balagurusamy; McGraw Hill; Eighth edition
2. Python Object-Oriented Programming; Steven F. Lott & Dusty Phillips; Packt Publishing Limited; 4th edition
3. Java The Complete Reference; Herbert Schildt; McGraw Hill; Eleventh edition

Reference book(s)

1. Object Oriented Programming C++; Robert Lafore; Pearson Education India; 4th edition
2. OOPS with C++ and Java; Balagurusamy; McGraw Hill Education 2014 edition
3. Python 3 Object-Oriented Programming; Dusty Phillips; Packt 3rd edition

Semester 4

How Human Languages work

Introduction

In this course, students will explore the fundamental concepts of human language, including phonetics, syntax, semantics, and pragmatics. The course will provide an overview of the structure and function of human language and explore how language is processed in the brain.

Course outcomes

At the end of this course, students will be able:

1. Understand the basic concepts of human language, including phonetics, syntax, semantics, and pragmatics.
2. Explore the structure and function of human language, including the sound systems of languages, grammatical structures, and the meanings of words and sentences.
3. Understand the social and cultural dimensions of language use, including language variation and change, multilingualism, and language attitudes.
4. Understand how language is processed in the brain, including the neural mechanisms of language comprehension and production.
5. Analyze the ways in which language reflects and shapes cultural and social identities.
6. Develop critical thinking skills by analyzing linguistic data and applying linguistic concepts to real-world problems.

Syllabus

Unit 1: Introduction to Language and Linguistics
Overview of Linguistics and its sub-fields, Phonetics and Phonology, Morphology

Unit 2: Syntax and Semantics
Syntax and Syntactic Structures, Semantics and Semantic Structures, Language Typology

Unit 3: Language Acquisition and Language Change
First and Second Language Acquisition, Language Change and Language Contact, Historical Linguistics

Unit 4: Sociolinguistics and Applied Linguistics
Sociolinguistics and Language Variation, Language Policy and Planning, Language and Identity, Language and Technology

Unit 5: Language in Context
Language and Culture, Language and Gender, Language and Power, Language and Globalization

Unit 6: Language Research and the Future of Linguistics
Research Methods in Linguistics, Current Debates in Linguistics, The Future of Linguistics

Assessment plan

Assessment component	Assessment type	Weightage %
Continuous assessment - 1	Multiple-choice test	20
Continuous assessment - 2	Multiple-choice test	20
Continuous assessment - 3	Presentation	20
Continuous assessment - 4	Multiple-choice test	20
Continuous assessment - 5	Presentation	20

Text book(s)

How Languages Work: An Introduction to Language and Linguistics by Carol Genetti; Cambridge University Press; 2nd edition

Reference book(s)

How Language Works; David Crystal; Penguin UK (2007 edition)

Tools and techniques for creative thinking

Introduction

This course introduces students to a variety of tools and techniques for generating creative ideas and solving problems. Students will learn strategies for brainstorming, mind mapping, idea generation, and critical thinking. The course will focus on developing practical skills for creative thinking that can be applied in a variety of contexts.

Course outcomes

At the end of this course, students will be able:

1. To use a variety of creative thinking tools and techniques to generate new ideas
2. To apply critical thinking skills to analyze and evaluate creative ideas and solutions
3. To identify and overcome barriers to creative thinking and problem-solving
4. To apply creative thinking skills in practical situations, such as in business, design, and technology
5. To develop effective communication skills for presenting and selling creative ideas
6. To work collaboratively with others to generate and implement creative solutions

Syllabus

Unit I – Introduction to Principles of Creativity
Mother and father of innovation, Levels of creativity, Creative environments

Unit II – Creativity tools
Creativity tools, Brainstorming techniques, Principles of brainstorming, Flip chart, Post-it, Alphabet brainstorming, Brainwriting, Grid brainstorming

Unit III – Thinking styles
The value of diversity, Principles of various thinking styles, Design thinking, Different thinking styles in practice

Unit IV – Morphological analysis
Principles of morphological analysis, Group application of plotline MA

Unit V – TRIZ theory
Principles and discussion, Contradiction matrix, TRIZ Parameters and Principles

Unit VI – SCAMPER
SCAMPER for architecture, team innovation using SCAMPER, Use of differen thinking styles

Unit VII – Using the tools in combination
Creative problem solving, Double diamond model, Circle brainstorming steps, E-tivity: B-link

Assessment plan

Assessment component	Assessment type	Weightage %
Continuous assessment - 1	Multiple-choice test	20
Continuous assessment - 2	Multiple-choice test	20
Continuous assessment - 3	Case study analysis	20
Continuous assessment - 4	Case study analysis	20
Continuous assessment - 5	Project followed by a presentation	20

Text book(s)

Lateral Thinking: A Textbook of Creativity; Penguin; 2016 edition

Reference book(s)

1. "Cracking Creativity: The Secrets of Creative Genius" by Michael Michalko (2001); Ten Speed Press; Revised ed. edition (26 June 2001)

2. "A Whack on the Side of the Head: How You Can Be More Creative" by Roger von Oech (2008); Grand Central Publishing; Special edition (5 May 2008)

Operating Systems

Introduction

This course introduces the concepts and principles of operating systems, including process management, memory management, file systems, and device management. Students will learn about various scheduling algorithms and memory allocation techniques used in operating systems. They will also be introduced to different types of operating systems and will learn about the trade-offs involved in designing and implementing these systems. Through practical assignments and projects, students will gain hands-on experience in implementing basic operating system functionalities. By the end of the course, students will have a solid understanding of the security and privacy issues in modern operating systems.

Course outcomes

At the end of this course, students will be able:

1. To understand the fundamental concepts of operating systems such as processes, threads, synchronization, and memory management.
2. To analyze the performance of various scheduling and memory allocation algorithms.
3. To compare and contrast different types of operating systems, such as batch, multi-programmed, and real-time systems.
4. To develop an understanding of device management, file systems, and virtualization.
5. To gain practical experience in implementing basic operating system functionalities.
6. To understand the security and privacy issues in modern operating systems.

Syllabus

Unit I - Computer Arithmetic & Processor Organisation
Computer Registers, Classification of Instruction – Size: three, two, one and zero instruction, Addressing Mode. Arithmetic and Logic Circuit Design. Instruction execution cycle: Sequencing of control signals, hardwired control, micro-programmed control, control signals, microinstructions, micro program sequencing, pre-fetching microinstructions. Introduction to graphical processing unit (GPU).

Unit II - Memory Organization
Memory hierarchy, Main memories chip architectures, memory address map, memory assembly to CPU. Auxiliary memory: magnetic tapes, disks (magnetic and SSDs). Associate memory: hardware organization, match logic, read and writes operations. Cache memory. Memory interleaving technique.

Unit III - Parallel Processing
Parallel processing, examples of parallel processing machines. Classification of parallel processing: Handler classification – pipeline processing, vector processing and array processing, Flynn’s classification – SISD, SIMD, MISD, MIMD. Pipeline conflicts.

Unit IV - Introduction to Operating Systems and Process Management
Introduction to operating systems. Process Management: what is a Process?, Process state, Process control block. Threads. Cooperating processes. Inter-process communication. CPU scheduling algorithms: Fist come first serve, shortest job first – primitive & non primitive, Round Robin. Deadlock: Necessary conditions for occurrence of deadlocks, Deadlock detection – Resource Allocation Graph. Deadlock Avoidance Algorithms: Banker Algorithm and Safety Algorithm.

Unit V - Memory Management
Memory allocation techniques: Continues (Multiprogramming with fixed number of tasks), Non-continues (Multiprogramming with variable number of tasks), Paging, Demand paging. Page replacement algorithms: First in first out, Least frequently used, Most frequently used, Optimal page replacement. Virtual memory concepts.

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Multiple-choice test, online	This assessment covers the basics of computer arithmetic, processor organization, memory hierarchy, and cache memory.	20
Continuous assessment - 2	Project-based	Students could be asked to implement a specific scheduling algorithm or choose from a set of options, and would be graded based on the functionality and efficiency of their implementation.	20
Continuous assessment - 3	Case-study analysis	This requires students to analyze a real-world operating system and identify its strengths and weaknesses. Students could be asked to examine a specific aspect of the operating system, such as its memory management or process scheduling, and provide recommendations for improvement.	20
Continuous assessment - 4	Multiple-choice test, online	This assessment will cover the basics of parallel processing, inter-process communication, and deadlock avoidance algorithms.	20
Continuous assessment - 5	Project-based	This assessment would require students to apply their knowledge of memory allocation techniques and virtual memory	20

		concepts. Students could be asked to implement a specific page replacement algorithm or choose from a set of options, and would be graded based on the functionality and efficiency of their implementation.	

Text book(s)

Operating Systems Concepts, Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Wiley, 2012.

Reference book(s)

1. The Design of the Unix Operating System, Maurice Bach, Pearson; 1st edition
2. Operating systems concepts; Avi Silberschatz, Peter Baer Galvin, Greg Gagne; Wiley; Ninth edition

Data Structure and Algorithms

Introduction

This course is focused on the study of data structures and algorithms, which are fundamental to computer science. It is designed to provide a deep understanding of the theory behind data structures and algorithms, as well as practical implementation techniques. The course is practice-heavy, and students will develop skills in algorithm design and analysis, problem-solving, and programming.

Course outcomes

At the end of this course, students will be able:

1. To explain the principles and concepts underlying data structures and algorithms, such as complexity analysis, recursion, and graph theory.
2. To design and implement efficient data structures and algorithms, using a variety of techniques and approaches.
3. To analyze the performance and correctness of data structures and algorithms, using mathematical and empirical methods.
4. To apply data structures and algorithms to solve real-world problems, across a range of application areas such as search, sorting, and graph algorithms.
5. To evaluate different data structures and algorithms, based on their suitability for specific problem domains and constraints.
6. To create and present well-structured and well-documented code that implements data structures and algorithms.

Syllabus

Unit I – Introduction
Algorithmic thinking, peak finding, Models of computation, Document distance, Python cost model

Unit II – Sorting and trees
Insertion sort, Merge sort, Heaps and heap sort, Binary search trees, BST sort, AVL trees and sort, Counting sort, radix sort, lower bounds for sorting and searching

Unit III – Hashing
Hashing with chaining, Table doubling, Karp-Rabin, Open addressing, Cryptographic hashing

Unit IV – Numerics
Integer arithmetic, Karatsuba multiplication, Square roots, Newton's method

Unit V – Graphs
Breadth first search, Depth first search, Topological mapping

Unit VI – Shortest paths
Single-source shortest paths problem, Dijkstra, Bellman-Ford, Speeding up Dijkstra

Unit VII – Dynamic Programming
Memoization, subproblems, guessing, bottom-up; Fibonacci, shortest paths, Parent pointers; text justification, perfect-information blackjack, String subproblems, psuedopolynomial time; parenthesization, edit distance, knapsack, Two kinds of guessing; piano/guitar fingering, Tetris training, Super Mario Bros

Unit VIII – Advanced topics
Computational complexity, Algorithms research topics

Assessment plan

Assessment component	Assessment type	Weightage %
Continuous assessment - 1	Coding test	20
Continuous assessment - 2	Coding test	20
Continuous assessment - 3	Coding test	20
Continuous assessment - 4	Coding test	20
Continuous assessment - 5	Coding test	20

Text book(s)

Data Structures and Algorithms Made Easy; Narasimha Karumanchi; CareerMonk Publications; 5th edition

Reference book(s)

Introduction to Algorithms; Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein; PHI Learning Pvt. Ltd. (Originally MIT Press); Third edition

Semester 5

English LSRW

Introduction

This is a course aimed at developing the four pillars of Technical English communication: Listening, Speaking, Reading and Writing. The course is designed to benchmark against the CEFR framework, and is tailored to focus on business and technical communication.

Course outcomes

At the end of this course, students will be able:

1. To comprehend and interpret spoken and written English at the CEFR B2 level
2. To produce spoken and written English at the CEFR B2 level
3. To develop active listening and speaking skills in order to participate in discussions, debates, and presentations
4. To improve reading speed, comprehension, and critical analysis of texts related to business and technical domains
5. To hone writing skills and produce effective business and technical documents such as emails, reports, proposals, and presentations
6. To apply effective communication strategies in a professional setting, including cultural awareness and intercultural communication.

Syllabus

Unit 1: Listening and Speaking
Introduction to listening and speaking skills, , Understanding different accents and intonation, Developing active listening skills, Participating in discussions and debates, Giving presentations and speeches

Unit 2: Reading
Introduction to reading skills, Skimming and scanning for information, Identifying main ideas and supporting details, Understanding tone and purpose, Reading for inference and implication

Unit 3: Writing

Introduction to writing skills, Planning and organizing written work, Writing effective emails and memos
Writing reports and proposals, Writing for specific audiences and purposes

Unit 4: Grammar and Vocabulary
Introduction to grammar and vocabulary, Understanding verb tenses and structures, Practicing correct sentence formation, Building vocabulary through context and word roots, Using idioms and phrasal verbs in communication

Unit 5: Business and Technical Communication
Introduction to business and technical communication, Writing effective resumes and cover letters
Conducting effective interviews, Understanding and writing technical documents, Communicating with clients and colleagues in professional settings,

Unit 6: Test Preparation and Practice
Introduction to the CEFR framework, Practice tests and quizzes to assess learning, Review and feedback on written and spoken communication, Goal setting for further improvement, Final project or presentation

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Multiple-choice + subjective, online + offline	Test of Reading, Writing, Listening and Speaking skills as per the CEFR framework	25
Continuous assessment - 2	Multiple-choice + subjective, online + offline	Test of Reading, Writing, Listening and Speaking skills as per the CEFR framework	25
Continuous assessment - 3	Multiple-choice + subjective, online + offline	Test of Reading, Writing, Listening and Speaking skills as per the CEFR framework	25
Continuous assessment - 4	Multiple-choice + subjective, online + offline	Test of Reading, Writing, Listening and Speaking skills as per the CEFR framework	25

Text book(s)

Professional English: for AKTU, Meenakshir Raman and Sangeetha Sharma, Oxford Publication 1st edition

Reference book(s)

Word Power Made Easy; Norman Lewis; Penguin Random House India; Latest edition 2015

Principles of Science

Introduction

The Principles of Science course provides a foundation in natural science principles and their application to computer science. The course will develop critical thinking and scientific communication skills and help students appreciate the relationship between science, technology, and society.

Course outcomes

At the end of this course, students will be able:

1. To understand the basic principles of natural science and their relevance to computer science
2. To develop critical thinking skills to analyze scientific problems and apply scientific principles to computer science problems
3. To develop skills in scientific communication and reporting
4. To understand the relationship between science and technology, and their impact on society
5. To develop an appreciation for the ethical considerations in science and technology
6. To develop an understanding of the scientific method and its application to computer science research

Syllabus

Unit 1: Introduction to Science and Technology
Definition and characteristics of science; Relationship between science and technology; Historical development of science and technology; Ethical considerations in science and technology

Unit 2: Physics Principles in Computer Science
Mechanics: motion, forces, work, energy, momentum; Electromagnetism: electric fields, magnetic fields, electromagnetic waves; Thermodynamics: laws of thermodynamics, heat transfer, phase transitions; Applications of physics principles to computer science problems; Understanding of the relationship between physics and computer science

Unit 3: Chemistry Principles in Computer Science
Atomic structure: electrons, protons, neutrons, periodic table; Chemical reactions: stoichiometry, acids and bases, oxidation and reduction; Thermodynamics: enthalpy, entropy, free energy; Applications of chemistry principles to computer science problems; Understanding of the relationship between chemistry and computer science

Unit 4: Biology Principles in Computer Science

Genetics: DNA, RNA, protein synthesis, inheritance patterns; Cell biology: structure and function of cells, cellular processes; Evolution: mechanisms of evolution, natural selection, speciation; Applications of biology principles to computer science problems; Understanding of the relationship between biology and computer science

Unit 5: Earth and Environmental Science Principles in Computer Science
Geology: plate tectonics, minerals, rocks; Meteorology: weather patterns, climate change; Ecology: ecosystems, biodiversity, conservation; Applications of Earth and environmental science principles to computer science problems; Understanding of the relationship between Earth and environmental science and computer science

Unit 6: Scientific Method and Research Ethics in Computer Science
Principles of the scientific method: observation, hypothesis, experimentation, analysis, conclusion; Ethical considerations in computer science research: privacy, security, bias, accountability; Skills in scientific communication and reporting: scientific writing, presentations, data visualization; Applications of the scientific method and research ethics to computer science research; Understanding of the importance of ethical considerations and effective communication in computer science research.

Assessment plan

Assessment component	Details of the assessment	Additional details, if any	Weightage
Continuous assessment - 1	Multiple-choice test	This quiz will cover Unit 1: Introduction to Science and Technology. It will include multiple-choice questions, short answer questions, and true/false questions.	10
Continuous assessment - 2	Project that requires analysis and a presentation + write-up	This project will be based on Unit 2: Physics Principles in Computer Science. Students will be required to choose a physics principle and apply it to a computer science problem. They will have to submit a report detailing their approach and findings.	20
Continuous assessment - 3	Project that requires analysis and a presentation + write-up	This project will be based on Unit 3: Chemistry Principles in Computer Science. Students will be given a computer science problem and will have to apply their knowledge of chemistry principles to solve the problem. They will have to submit a report detailing their approach and findings.	20

Continuous assessment - 4	Project that requires analysis and a presentation + write-up	This project will be based on Unit 4: Biology Principles in Computer Science. Students will be required to choose a biology principle and apply it to a computer science problem. They will have to submit a report detailing their approach and findings.	20
Continuous assessment - 5	Project that requires analysis and a presentation + write-up	This assignment will be based on Unit 5: Earth and Environmental Science Principles in Computer Science. Students will be given a computer science problem and will have to apply their knowledge of earth and environmental science principles to solve the problem. They will have to submit a report detailing their approach and findings.	20
Continuous assessment - 6	Multiple-choice test	This assignment will be based on Unit 5: Earth and Environmental Science Principles in Computer Science. Students will be given a computer science problem and will have to apply their knowledge of earth and environmental science principles to solve the problem. They will have to submit a report detailing their approach and findings.	10

Text book(s)

1. Principles of Science by Donald E. Simanek and John R. Erickson (Pearson Education India, 2019)
2. The Sciences: An Integrated Approach by James Trefil and Robert M. Hazen (published by John Wiley & Sons, latest edition)

Reference book(s)

1. Science Matters: Achieving Scientific Literacy by Robert M. Hazen and James Trefil (Penguin Random House India, 2017)
2. Science and Technology in World History: An Introduction by James E. McClellan III and Harold Dorn (Johns Hopkins University Press, 2018)
3. Physics for Scientists and Engineers by Randall D. Knight (published by Pearson, latest edition)
4. Chemistry: The Central Science by Theodore E. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, and Patrick M. Woodward (published by Pearson, latest edition)

5. Biology: Concepts and Connections by Neil A. Campbell, Jane B. Reece, Martha R. Taylor, and Eric J. Simon (published by Pearson, latest edition)
6. Earth Science by Edward J. Tarbuck, Frederick K. Lutgens, and Dennis Tasa (published by Pearson, latest edition)
7. Research Methods in Computer Science by E. Lesk (published by Springer, latest edition)

Computer Organization & Architecture

Introduction

This course provides an introduction to computer organization and architecture, which deals with the physical components of a computer system and how they work together to execute instructions. Topics covered include CPU design, memory hierarchy, I/O systems, and assembly language programming.

Course outcomes

At the end of this course, students will be able:

1. To explain the basic components of computer systems and their functions at a low level, including CPU, memory, and I/O systems.
2. To analyze the performance of computer systems based on metrics such as clock rate and CPI.
3. To design and implement simple CPU and memory systems using hardware description languages such as Verilog.
4. To write and debug assembly language programs that interact with system hardware.
5. To evaluate the trade-offs involved in different design choices for computer systems, such as the size of the instruction set or the level of parallelism.
6. To apply knowledge of computer organization and architecture to optimize code for performance and minimize energy consumption.

Syllabus

Unit I
Basic functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU - registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study - instruction sets of some common CPUs.

Unit II
Data representation: signed number representation, fixed and floating point representations, character representation. Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication - shift-and-add, Booth multiplier, carry save multiplier, etc. Division - non-restoring and restoring techniques, floating point arithmetic.

Unit III

CPU control unit design: hardwired and micro-programmed design approaches, Case study - design of a simple hypothetical CPU.

Memory system design: semiconductor memory technologies, memory organization.

Unit IV
Peripheral devices and their characteristics: Input-output subsystems, I/O transfers - program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes - role of interrupts in process state transitions.

Performance enhancement techniques

Unit V
Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs block size, mapping functions, replacement algorithms, write policy.

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Multiple-choice test, online	This assessment could cover the instruction set architecture of a CPU, including registers, addressing modes, and instruction execution cycle.	20
Continuous assessment - 2	Project-based	This assessment could ask students to design a simple hypothetical CPU using either a hardwired or micro-programmed approach. This could be a project-based assignment where students submit code or a detailed design document.	20
Continuous assessment - 3	Multiple-choice test, online	This can be a test of students' understanding of Computer Arithmetic.	20
Continuous assessment - 4	Project-based	This assessment could ask students to design a memory system using semiconductor memory technologies, including memory organization and cache	20

		memory. This could be a project-based assignment where students submit code or a detailed design document.	
Continuous assessment - 5	Project-based	This assessment could ask students to work in groups to research and present on different performance enhancement techniques, including pipelining and memory organization. The project could involve creating a presentation or a demo to showcase their understanding of the concepts.	20

Text book(s)

Computer Organization and Design; Patterson; Elsevier; 6th edition

Reference book(s)

1. Computer Architecture, Berhooz Parhami; Oxford University Press (19 April 2012)
2. Computer System Architecture; Mano M Morris; Pearson 3rd edition

Formal Language & Automata Theory

Introduction

Formal language and automata theory is a branch of computer science that studies the theoretical foundation of computer science, including the formal languages that computers can recognize and the automata that can recognize those languages. This course is designed to give students an understanding of formal languages, grammars, and automata, and how to use them to solve practical problems.

Course outcomes

At the end of this course, students will be able:

1. To identify the regular and context-free languages that a given automaton can recognize.
2. To design regular expressions and context-free grammars for given languages.
3. To construct finite automata, pushdown automata, and Turing machines to recognize given languages.
4. To analyze the time and space complexity of algorithms that operate on formal languages.
5. To apply the principles of formal languages and automata to real-world problems, such as pattern matching and parsing.
6. To evaluate and critique different models of computation and their relative strengths and weaknesses.

Syllabus

Unit 1 Automata methods and Finite Automata
Introduction to formal proof, Additional forms of proof, Inductive proofs, The central concepts of Automata theory, Deterministic finite automata, Nondeterministic finite automata, Text search, Finite automata with Epsilon transitions

Unit 2– Regular expressions and languages
Regular expressions, Applications, Algebraic laws for regular expressions, Proving languages not to be regular, Closure properties of regular languages, Decision properties, Equivalence and minimization

Unit 3 Context free Grammar and Languages
Context free grammar, Parse trees, Applications, Ambiguity

Unit 4 Pushdown Automata
The languages of a PDA, Equivalance of PDA and CFG, Deterministic PDA

Unit 5 Intro to Turing machines
Problems that computers cannot solve, The Turing machine, Programming techniques for Turing machine, Extensions to the basic Turing machine

Unit 6 Undecidability and Intractable problems
P and NP, NP-complete problem, A restricted satisfiability problem, Additional NP-complete problems,

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Multiple-choice test, online	This assessment could cover concepts such as deterministic and non-deterministic finite automata, the text search algorithm, and finite automata with Epsilon transitions.	30
Continuous assessment - 2	Project-based	This assessment could involve students implementing regular expressions to solve a real-world problem, such as pattern matching in text files.	40
Continuous assessment - 3	Multiple-choice test, online	This assessment could be a comprehensive exam covering all the topics covered in the course, with a focus on Turing machines and undecidability.	30

Text book(s)

Automata Theory Language & Computation; Hopcraft; Pearson 3rd edition

Reference book(s)

1. Theory of Computer Science: Automata, Languages and Computation; KLP Mishra; Prentice Hall India Learning Private Limited; 3rd edition
2. Switching and Finite Automata Theory; Jha; Cambridge University Press; South Asian edition (8 June 2010)

Design & Analysis of Algorithms

Introduction

This course provides an in-depth understanding of fundamental algorithms, algorithm design techniques, and algorithm analysis. Students will gain experience in designing and analyzing algorithms, which will help them solve computational problems more efficiently.

Course outcomes

At the end of this course, students will be able:

1. To apply algorithmic problem-solving techniques using a variety of algorithm design methods.
2. To analyze the time and space complexity of algorithms and compare the efficiency of different algorithms for the same problem.
3. To select appropriate data structures to optimize algorithms for specific problems.
4. To demonstrate proficiency in dynamic programming, greedy algorithms, and other classical algorithmic techniques.
5. To apply algorithmic solutions to real-world problems and evaluate the quality of the solution.
6. To analyze the limitations and challenges of algorithms in various contexts and assess the ethical implications of algorithm design.

Syllabus

Unit I - Fundamentals of Algorithms and mathematics
Problem, algorithm definitions, Mathematics for algorithmic sets, Functions and relations, Combinations, Vectors and matrices, Linear inequalities and linear equations

Unit II - Analysis of Algorithms
Orders of Magnitude (Asymptotic notations) Growth rates, some common bounds (constant, logarithmic, linear, polynomial, exponential) Average and worst case analysis
Analysing control statements Recurrence Relations- substitution, change of variables, master’s method

Unit III - Sorting and searching algorithms

Selection sort, bubble sort, insertion sort Sorting in linear time, count sort Linear search

Unit IV - Divide and conquer algorithms
Quick sort, worst and average case complexity, Merge sort Matrix multiplication, Binary search, Binary search tree

Unit V - Greedy algorithms
General characteristics, Problem solving using Greedy methods, Activity selection problem, MST, The Knapskack problem

Unit VI - String matching
The naive string matching algorithm, The Rabin-Karp algorithm, String Matching with infinite automata

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Coding test	Students could be given a programming problem related to sorting and searching algorithms, such as implementing quicksort or binary search. They would be expected to write efficient and correct code.	20
Continuous assessment - 2	Coding test	Students could be given a programming problem related to dynamic programming or greedy algorithms, such as the knapsack problem or coin change problem. They would be expected to write efficient and correct code.	20
Continuous assessment - 3	Coding test	Students could be given a programming problem related to string matching or graph algorithms, such as finding the shortest path between two nodes or implementing the Rabin-Karp algorithm. They would be expected to write efficient and correct code.	20
Continuous assessment - 4	Algorithm analysis	Students could be given a set of algorithms and asked to analyze their time complexity using Big-O notation. They would need to demonstrate an understanding of	20

		how to analyze algorithms and express their complexity using the appropriate notation.	
Continuous assessment - 5	Case study analysis	Students could be given a real-world problem related to algorithms, such as optimizing a transportation network or scheduling appointments for a medical facility. They would be expected to analyze the problem and propose an algorithmic solution, including a description of the algorithm, its time complexity, and any trade-offs involved.	20

Text book(s)

Design And Analysis Of Algorithms; S Sridhar; Oxford University Press; 2014 edition

Reference book(s)

1. "The Design of Approximation Algorithms" by David P. Williamson and David B. Shmoys (Cambridge University Press, 2010)
2. "Computational Complexity: A Modern Approach" by Sanjeev Arora and Boaz Barak (Cambridge University Press, 2009)

Semester 6

Discovering Self

Introduction

Discovering Self is a course designed to help students explore and develop their personal identity, emotional intelligence, and communication skills. Through a variety of activities and exercises, students will gain insights into their own strengths and weaknesses, and develop strategies for personal growth and development.

Course outcomes

At the end of this course, students will be able:

1. To develop self-awareness and introspection skills
2. To understand the importance of emotional intelligence and its role in personal and professional life
3. To learn effective communication skills to express thoughts, ideas, and emotions
4. To develop problem-solving and decision-making skills

5. To discover personal strengths and weaknesses, and strategies for personal growth and development
6. To understand the impact of personal values and beliefs on decision-making and behavior

Syllabus

Unit 1: Self-awareness and Introspection
Definition and importance of self-awareness; Techniques for introspection and self-reflection; Identifying personal values, beliefs, and biases; Understanding emotions and their impact on behavior; Developing self-compassion and self-acceptance

Unit 2: Emotional Intelligence
Definition and importance of emotional intelligence; Understanding emotions and their role in communication; Developing empathy and social awareness; Managing emotions and stress; Developing emotional regulation and resilience

Unit 3: Effective Communication
Definition and importance of effective communication; Verbal and nonverbal communication skills;
Active listening and responding skills; Overcoming communication barriers; Developing assertiveness and conflict resolution skills

Unit 4: Problem Solving and Decision Making
Definition and importance of problem solving and decision making; Analyzing problems and identifying root causes; Generating and evaluating alternative solutions; Making effective decisions; Implementing and evaluating decisions

Unit 5: Personal Growth and Development
Definition and importance of personal growth and development; Identifying personal strengths and weaknesses; Developing strategies for personal growth and development; Setting goals and creating action plans; Cultivating a growth mindset

Unit 6: Values and Beliefs
Understanding personal values and beliefs; Identifying how values and beliefs impact decision-making and behavior; Developing an ethical framework for decision-making; Understanding and respecting cultural differences; Managing cognitive biases and heuristics

Assessment plan

Assessment component	Details of the assessment	Additional details, if any	Weightage %
Continuous assessment - 1	Personal reflection paper	Students will write a personal reflection paper on their self-awareness and introspection journey. The paper should be based on their experiences with techniques for introspection and self-reflection, as well as their identified values, beliefs, and biases.	20
Continuous assessment - 2	Emotional intelligence case study	Students will be given a case study related to emotional intelligence and will have to analyze it and provide a solution. The case study will focus on managing emotions and stress, developing emotional regulation and resilience, and developing empathy and social awareness.	20
Continuous assessment - 3	Communication project	Students will work on a communication project that includes verbal and nonverbal communication skills, active listening and responding skills, and overcoming communication barriers. The project should include a presentation or a video showcasing their communication skills.	20
Continuous assessment - 4	Decision making simulation	Students will be given a problem-solving and decision-making simulation where they will have to analyze problems, identify root causes, generate and evaluate alternative solutions, and make effective decisions. The simulation will be designed to mimic real-world	20

		scenarios.	
Continuous assessment - 5	Personal growth plan	Students will develop a personal growth plan that includes identifying personal strengths and weaknesses, developing strategies for personal growth and development, setting goals, and creating action plans. The plan should be based on the concepts learned in the course and should be tailored to the student's individual needs and aspirations.	20

Text book(s)

Emotional Intelligence 2.0 by Travis Bradberry and Jean Greaves, TalentSmart (2015)

Reference book(s)

1. Crucial Conversations: Tools for Talking When Stakes Are High by Kerry Patterson, Joseph Grenny, Ron McMillan, and Al Switzler, McGraw-Hill Education (2011)
2. The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change by Stephen R. Covey, Simon & Schuster (2013)
3. Mindset: The New Psychology of Success by Carol S. Dweck, Ballantine Books (2007)
4. Thinking, Fast and Slow by Daniel Kahneman, Farrar, Straus and Giroux (2011)

Fundamentals of Business Management

Introduction

This course provides an introduction to the key principles and practices of modern business management. It is designed to equip students with the foundational knowledge and skills needed to manage people, resources, and processes effectively, and to develop a strategic mindset that enables them to make sound business decisions in a dynamic and complex environment.

Course outcomes

At the end of this course, students will be able:

1. To understand the fundamental concepts and principles of modern business management, including organizational structures, functions, and processes.
2. To develop a strong foundation in core business disciplines, such as accounting, finance, marketing, and operations management.
3. To acquire the necessary knowledge and skills to manage people effectively, including leadership, motivation, and communication.
4. To understand the importance of strategic thinking and planning in business management, and to develop the ability to formulate and execute effective business strategies.

5. To learn to manage resources efficiently and effectively, including financial, technological, and human resources.
6. To develop critical thinking and problem-solving skills, and to apply them in real-world business scenarios.

Syllabus

Unit 1: Introduction to business management and Marketing
How business operate, Branding, customer centricity, Go-to market strategies, different modes of marketing

Unit 2: Financial Accounting
Balance sheet, Accrual accounting, Income sheet, Cash flows, Ratio analysis

Unit 3: Managing social and human capital
Motivation and reward, Tasks, jobs and system of work, Making good & timely decisions, Designing and changing the organization's architecture

Unit 4: Background to Entrepreneurship
Theories of entrepreneurship, Activity scope and role in modern society, The effects of entrepreneurial activity on economic systems, contributions and benefits of entrepreneurial activity, Entrepreneurship in Oman. Problems faced by small firms, types of entrepreneurs and innovators.

Unit 5: The Entrepreneur
The individual in terms of psychology, personality and trait theories; The individual in terms of motivation and achievement theories; The individual in terms of behaviour and characteristics theories; Differentiated entrepreneur typologies.

Unit 6: Conceiving a Business Idea and Creating a Business Plan
Business Idea - Models for new ventures, idea generation, screening ideas, business analysis, and feasibility studies.
Business Plan - Purpose and benefits, design of a business plan, layout and content, focused recipient, approaching potential investors.

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Multiple-choice	A quiz testing the concepts of business learned	20
Continuous assessment - 2	Case-study analysis	Provide a case study of a real business and ask students to analyze the business management and marketing	20

		strategies used. Students should identify key challenges, successes, and areas for improvement.	
Continuous assessment - 3	Financial statement analysis	Provide financial statements for a hypothetical business and ask students to analyze the company's financial health using ratio analysis. Students should identify strengths and weaknesses of the company's financial position and make recommendations for improvement.	20
Continuous assessment - 4	Business plan proposal	Ask students to identify a potential entrepreneurial opportunity and create a business plan for a new venture. The plan should include a market analysis, financial projections, and an overview of the proposed business model.	20
Continuous assessment - 5	Project-based	Students to identify a potential entrepreneurial opportunity and create a business plan for a new venture. The plan should include a market analysis, financial projections, and an overview of the proposed business model.	20

Text book(s)

1. "Principles of Management" by Peter F. Drucker (HarperCollins, 2017)
2. "Fundamentals of Management" by Stephen P. Robbins and David A. DeCenzo (Pearson, 2017)

Reference book(s)

1. "The Lean Startup" by Eric Ries (Crown Business, 2011)
2. "Blue Ocean Strategy" by W. Chan Kim and Renée Mauborgne (Harvard Business Review Press, 2015)
3. "The 7 Habits of Highly Effective People" by Stephen R. Covey (Simon & Schuster, 2013)
4. "Good to Great" by Jim Collins (Harper Business, 2001)

Compiler Design

Introduction

The Compiler Design course is designed to teach students the principles and techniques used in building compilers for programming languages. Students will learn how compilers work and how to build a simple compiler from scratch.

Course outcomes

At the end of this course, students will be able:

1. To apply the principles of formal language and automata theory in building compilers for programming languages.
2. To design and implement the lexical analyzer and parser for a programming language.
3. To generate intermediate code from source code using different techniques.
4. To optimize code generation using various optimization techniques.
5. To implement error handling and debugging mechanisms in a compiler.
6. To evaluate and compare different compiler design and optimization techniques.

Syllabus

Unit 1 Introduction and Directed Translator
Language processors, Structure of a compiler, Evolution of programming languages, The science of building a compiler, Applications of computer technology, Syntax – Directed translation, Parsing, A translator for simple expressions, Lexical analysis, Symbol tables, Intermediate code generation

Unit 2 - Lexical analysis
The role of lexical analyzer, Input buffering, Tokens, Lexical-Analyzer generator, Finite Automata, Design of a lexical-analyzer generator

Unit 3 - Syntax analysis
The role of parser, Context-free grammar, Writing a grammar, Top-down parsing, Bottom-up parsing, LR parsing, Parser generators

Unit 4 Syntax directed translation
Evaluation order for SDDs, Applications, Schemes, Implementing L-attributed SDDs

Unit 5 Intermediate Code Generation
Variations of syntax trees, Three address code, Types and declaration, Translation of expressions, Type checking, Control flow, Backpatching, Switch statements

Unit 6 Run time environments
Issues in the design of a code generator, The target language, Addresses in the target code, Basic blocks and flow graphs, Optimization of basic blocks, A simple code generator, Peephole optimization, Dynamic Programming code-generation

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Subjective, online	Students are given a context-free grammar and asked to write a parser for it using a parsing algorithm of their choice (e.g., LL(1), LR(1), etc.). They would be evaluated based on the correctness and efficiency of their parser.	25
Continuous assessment - 2	Subjective, online	Students are given a small program and asked to optimize its intermediate code. They would be evaluated based on the quality of their optimization (e.g., number of instructions reduced, execution time improved, etc.).	25
Continuous assessment - 3	Multiple-choice	Students take a quiz on the concepts related to symbol tables, such as scope, binding, and lifetime.	25
Continuous assessment - 4	Project-based	Students will work on a project that demonstrates their understanding of compiler design principles and techniques. The project could involve designing and implementing a compiler for a simple programming language, or extending the functionality of an existing compiler. The project should include a written report that explains the design choices made and the implementation details, as well as a demonstration of the working compiler. The project will be evaluated based on the quality of the design, implementation, and documentation.	25

Text book(s)

Compilers: Principles Techniques and Tool; Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffry D. Ullman; Pearson 2nd edition

Reference book(s)

1. "Engineering a Compiler" by Keith D. Cooper and Linda Torczon (2nd Edition, 2011, Morgan Kaufmann)
2. "Modern Compiler Implementation in Java" by Andrew W. Appel (2nd Edition, 2002, Cambridge University Press)
3. "Introduction to Compiler Construction" by Thomas W. Parsons (2001, Addison-Wesley)
4. "Language Implementation Patterns: Create Your Own Domain-Specific and General Programming Languages" by Terence Parr (2010, Pragmatic Bookshelf)
5. "Writing Compilers and Interpreters: A Software Engineering Approach" by Ronald Mak (3rd Edition, 2009, Wiley)

Computer Networks

Introduction

This course will cover the fundamental concepts and principles of computer networks, including network architecture, protocols, and services. Students will learn about various network technologies, such as LAN, WAN, and wireless networks, and their applications in different contexts. The course will also address network security and management issues.

Course outcomes

At the end of this course, students will be able:

1. To identify the different components and layers of computer networks.
2. To explain the functions of different protocols used in computer networks.
3. To analyze the performance and limitations of different network architectures.
4. To design and implement basic network configurations using routers and switches.
5. To troubleshoot common network issues using various network analysis tools.
6. To evaluate the security concerns and design solutions to ensure network security.

Syllabus

Unit 1 Internetworking and Routing
Internet architecture, Unicast IP Forwarding and Routing, Internet Routing in-the-Wild (Measurement), Big Fast Routers, Security Issues in the Internet Architecture, Robustness

Unit 2 – Resource Management
End-to-End Congestion Control, Router-Assisted Congestion Control, Active Queue Management, and Scheduling, Modeling and Measurement, Adaptive Applications and Internet QoS

Unit 3– Network Services
Wireless/Mobile Networking, Naming: DNS, Peer-to-Peer Networking, Distributed Hash Tables, Overlay Routing, Multicast, Network Protection, Reliable Transport and Congestion Control, Unicast Routing, Adaptive and Network-Aware Applications, Traffic Engineering, Flow Modeling, Wireless Protocols, Naming, Web Caching

Assessment plan

Assessment component	Assessment type	Details	Weightage %
Continuous assessment - 1	Objective	Multiple-choice quiz on unit 1	25
Continuous assessment - 2	Project-based	Students are assigned to work in groups and simulate a computer network using a network simulator tool, such as GNS3 or Packet Tracer. Students can design and implement a network topology that reflects the topics covered in the course. The project can include configuring routers and switches, implementing routing protocols, and testing the network for security, reliability, and performance.	25
Continuous assessment - 3	Project-based	Students are asked to conduct research on a particular topic related to computer networks and present their findings to the class. For example, students can research the latest advances in wireless protocols or analyze the benefits and drawbacks of different routing protocols. The research project can be in the form of a presentation or a written report.	25
Continuous assessment - 4	Project-based	Students are asked to design a computer network that meets specific requirements, such as high availability, security, and scalability. The project can include designing network topology, selecting hardware and software components, and configuring the network for different services and applications. Students can present their designs to the class and receive feedback from their peers and the instructor.	25

Text book(s)

1. A S Tanenbaum, Computer Networks, 5th Ed., Pearson, 2010.
2. B.A. Forouzan, TCP/IP Protocol Suite, 4th Ed., TMH, 2010.

Reference book(s)

1. TCP/IP illustrated, Volume 1: The Protocols, W.R. Stevens, 2nd Ed., Addison-Wesley, 2015.
2. Internetworking with TCP/IP Principles, Protocols and Architecture, D E. Comer, 6th Ed., Pearson, 2013.

Semester 7

Introduction to Philosophy

Introduction

In this course, students will be introduced to fundamental concepts in philosophy such as logic, ethics, epistemology, metaphysics, and aesthetics. They will learn about the major philosophical ideas of historical and contemporary thinkers and explore various philosophical arguments.

Course outcomes

At the end of this course, students will be able:

1. To identify and explain the major philosophical concepts and ideas.
2. To analyze and evaluate philosophical arguments.
3. To develop the ability to think critically and creatively about philosophical problems.
4. To apply philosophical theories and concepts to real-world situations.
5. To engage in philosophical discussions and debates with peers.
6. To appreciate the relevance of philosophy to personal and professional life.

Syllabus

Unit 1: Morality
The status of morality, Objectivism, Relativism, Emotivism

Unit 2: What is knowledge?
The basic constituents of knowledge, the classical account of knowledge, The Gettier problem, Choices

Unit 3: Free will
Determinism, Libetarianism, Compatabilism, Hard determinism, Free will and do we have it?

Unit 4: Obligation to obey the law

The grounds of political obligation, Consent, Fairness, Gratitude and Benefit

Unit 5: Should you believe what you hear?
Reid's challenge to Hume, Reid's Argument, Enlightenment, Intellectual Autonomy

Assessment plan

Assessment component	Assessment type	Weightage %
Continuous assessment - 1	Case-study analysis and presentation	20
Continuous assessment - 2	Case-study analysis and presentation	20
Continuous assessment - 3	Case-study analysis and presentation	20
Continuous assessment - 4	Case-study analysis and presentation	20
Continuous assessment - 5	Case-study analysis and presentation	20

Text book(s)

Philosophy Made Slightly Less Difficult; Garrett J. Deweese & J. P. Moreland; IVP Academic; Second edition

Reference book(s)

1. The Big Questions: A Short Introduction to Philosophy by Robert C. Solomon and Kathleen M. Higgins, published by Wadsworth Publishing (2011).
2. Think: A Compelling Introduction to Philosophy by Simon Blackburn, published by Oxford University Press (2001).
3. Philosophy: The Basics by Nigel Warburton, published by Routledge (2012).
4. The Story of Philosophy by Will Durant, published by Pocket Books (1991).
5. An Introduction to Indian Philosophy; Satishchandra Chatterjee; Rupa & Co 2012 edition

Electives

This forthcoming section of the doc contains a tentative list of courses offered (not a detailed syllabus) for the electives.

Academic Elective #1

1. Cloud computing
2. Distributed systems
3. Data Mining and Warehousing

Academic Elective #2

1. Cryptography
2. Internet of Things
3. System Design

Foundation Elective

1. Human Mind and Behaviour
2. Organization Behaviour
3. Foreign language (Global options provided such as French/ Spanish/ German/ Japanese etc.)
4. Design Thinking 101

Semester 8

Skilling Elective

1. Unix Shell Programming
2. AWS and AWS Security
3. Data Modeling and Visualization

Assessment plan for Integrated Work

During semesters 3 through 8, students participate in *Integrated Work* with partner companies. This refers to paid remote internships with tech recruiters. This goes on to provide students with valuable real-world experience and industry immersion, that will help them gain miles in their eventual graduation outcomes, far ahead of their peers in other programs.

Credits are allocated to Integrated Work each semester, and the evaluation schema is as follows.

Plan to track Progress

During the internship the student will report plans and progress in written and oral form. These will be assessed formative.

Progress Report

During the course of the internship, the student has to submit fortnightly reports detailing their progress for the month on the internship. This should cover:

- Analysis of the work done at the organization
- Learnings thus far
- Challenges faced in the fortnight with proposed solutions

This is evaluated by a supervisor mentor from Kalvium, and suitable feedback/ support is provided.

Internship Report

After the internship, the student has to hand in his/her internship report before a predetermined deadline. This report consists of the following.

- Analysis of the project done at the organization (matter-of-fact description of the work carried out)
- Analysis and reflection of the learning process (this involves the progress in learning over six months of the integrated work. This may include general as well as personal competency-level learnings).

Internship Presentation

After handing in his/her report, the student presents his/her internship report to a panel. This panel consists of unbiased assessors (not the supervising mentor) The supervising mentor may also attend the internship presentation.

An assessment lasts one hour, consisting of a presentation of the student's internship work (30 minutes), and a question round (30 minutes).

Assessment Methodology

The following will be provided as weightages for evaluating a student's performance in this stint of Integrated Work.

- Evaluation of the Progress Report by the supervising mentor (20%)
- Evaluation of the Internship Report/ Presentation by the panel (20%)
- Monthly Performance rating (weighted average) by the supervising manager from the company (60%)

The monthly ratings could be based on various aspects of the student's performance such as punctuality, professionalism, quality of work, ability to meet deadlines, willingness to learn, and collaboration with team members.