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### SUMMARY

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<th>OE</th>
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| MODULE 1 | SELF-INTRODUCTION . THE LINGUISTIC ACT OF NARRATING | Oral Fluency: Introducing oneself-introducing friend/family (connecting campus) - Reading: biographies (subject based) reading strategies-skimming-scanning-predicting- Language Focus: Use of present and past tense forms of verbs-(Degrees of Comparison) - Lexical Development: Adjectives-learning topic related vocabulary (approximately 30)- Writing: short biographies with the given details of (related to specific branches of engineering) Listening: listening to speeches by specialists from various branches of engineering and completing activities such as answering questions , identifying the main ideas of the listening text, style of the speaker (tone and tenor) and making inferences. | At the end of the module, students should be able to:  
- Introduce oneself for at least 2 minutes with minimal intrusive errors and breaks.  
- Write a paragraph by listing information chronologically |

<table>
<thead>
<tr>
<th>SUGGESTED ACTIVITIES</th>
<th>SUGGESTED EVALUATION METHODS</th>
</tr>
</thead>
</table>
| Lectures on the Communicative aspects of language use.  
Practical-Listening, Speaking and Writing | Quizzes  
Assignments  
Small Group Work |

12 0 0 9
| MODULE 2 | COMPARING AND CONTRASTING | Oral Fluency: Comparing and Contrasting (e.g. Facebook and Whatsapp)- **Language Focus**: verbal phrases-compound nouns(noun strings)-simple present and present perfect, future tense- **Lexical Development**: Discourse Analysis-lexical links-related to the function of comparing and contrasting-lexical items related to the reading texts- **Reading**: texts on comparing and contrasting concepts in engineering and technology (e.g. Computers and Artificial intelligence)  
**Listening**: gap-filling exercises- **Writing**: Definitions(short and long)-paragraph writing especially comparing and contrasting discourse | At the end of the module, students should be able to:  
- Compare and contrast products/concepts both in speech and writing |

<table>
<thead>
<tr>
<th><strong>SUGGESTED ACTIVITIES</strong></th>
<th><strong>SUGGESTED EVALUATION METHODS</strong></th>
</tr>
</thead>
</table>
| - Lectures on the Communicative aspects of language use.  
- Practical-Listening, Speaking and Writing | - Quizzes  
- Assignments  
- Small Group Work |

12009
| MODULE 3 | STATING PROBLEMS AND EXPRESSING SOLUTIONS | Oral Fluency: Small Group Discussion (e.g. The changing face of the software Industry)-Language Focus: sentence level linguistics (construction of function-based sentences)-past continuous and present perfect continuous and future tenses-Lexical Development: learning vocabulary related to content and function (approximately 30)-Reading: passages discussing problems and solutions (e.g. automation in the software industry and employment opportunities in the next decade)-Listening: TED talks & discussions-Writing: lengthy paragraphs (e.g. What does the future hold for the software industry?)-Formal letter writing-highlighting problems and offering solutions. | At the end of the module, students should be able to:  
- Participate in small group discussions effectively.  
- Write extended paragraphs  
- Listen and comprehend long talks |

<table>
<thead>
<tr>
<th>SUGGESTED ACTIVITIES</th>
<th>SUGGESTED EVALUATION METHODS</th>
</tr>
</thead>
</table>
| • Lectures on the Communicative aspects of language use.  
• Practical-Listening, Speaking and Writing | • Quizzes  
• Assignments  
• Small Group Work |

| MODULE 4 | EXPRESSING CAUSAL RELATIONS | Oral Fluency: speaking skills practice in small groups. (e.g. uses and abuses of the mobile phone) Language Focus: use of passive voice forms of verbs – past participle forms (sentence construction for expressing causal relations)-Lexical Development: specialized vocabulary to establish causal relations-Reading: texts on cause and effect functions- texts on process description-Listening: | At the end of the module students should be able to:  
- Write two paragraphs describing and interpreting visual data (charts, tables etc.)  
- Read and comprehend texts expressing causal relations |

Attested
### EVALUATION METHOD TO BE USED:

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#### MODULE 5

**EXTENDED SPEECH**

**Oral Fluency:** making mini presentations (e.g. the working of an algorithm)

**Language Focus:** passive voice and use of phrases

**Lexical Development:** specialist vocabulary related to theme-cohesive ties related to process description (sequential expressions)

**Reading:** Pie chart/Table/Bar chart interpretation

**Listening:** drawing a flowchart

**Writing:** channel conversion—diagram to written forms

**SUGGESTED ACTIVITIES**

- Lectures on the Communicative aspects of language use.
- Practical-Listening, Speaking and Writing

**SUGGESTED EVALUATION METHODS**

- Quizzes
- Assignments
- Small Group Work

At the end of the module, students should be able to:

- Make short presentations
- Read and interpret visual data
- Write a process description

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EVALUATION METHOD TO BE USED:

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[Attested]

**DIRECTOR**

Centre for Academic Courses
Anna University, Chennai-600 025
Prerequisites for the course: None

**OBJECTIVES:**
- To introduce the basic concepts of physics.
- To develop critical thinking through problem solving related to physics
- To identify, analyze and implement possible applications with the goal of achieving the most efficient and effective usage of conceptual physics.

**MODULE I:**

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**SUGGESTED ACTIVITIES:**
- In Class activity: Simple harmonic motion
- Practical - Nonuniform bending: Determination of Young’s modulus.
- EL: Cantilever, Torsional pendulum, Simple harmonic oscillations

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE II:**

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</table>


**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- In class activity: Derivation and Simplification
- EL – Practical Problems - Waves – Resonance – Doppler effect of sound – standing waves in a string
- **Practical – Torsional Pendulum: Determination of rigidity modulus of wire and moment of inertia of disc.**

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
### MODULE III:

- **L**: 3  
- **T**: 0  
- **P**: 2  
- **EL**: 3  


**SUGGESTED ACTIVITIES:**
- EL: Piezoelectric effect, acoustic grating
- In class activity: Ultrasonic oscillator construction
- Practical - Ultrasonic interferometer: Determination of velocity of sound and compressibility of liquids.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE IV:

- **L**: 3  
- **T**: 0  
- **P**: 2  
- **EL**: 3  


**SUGGESTED ACTIVITIES:**
- Flipped Class room
- EL: Thermal expansion, bimetals, Compound media, Thermal conductivity
- Practical – Lee’s disc: Determination of thermal conductivity of a bad conductor.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE V:

- **L**: 3  
- **T**: 0  
- **P**: 2  
- **EL**: 3  


**SUGGESTED ACTIVITIES:**
- Applications in class discussion
- EL – Thin films, antireflection coating, Air-wedge, Interferometry
- Practical – Air-wedge: Determination of thickness of thin sheet/wire.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
# MODULE VI:

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Lasers – Principles and applications – Einstein’s coefficients – laser resonator - semiconductor laser

**SUGGESTED ACTIVITIES:**
- Introduction in class
- EL: Laser theory, principles, industrial applications, fiber optics
- Flipped Classroom for further study
- Practical – Compact disc: Determination of width of groove using laser

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

# MODULE VII:

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**SUGGESTED ACTIVITIES:**
- Combinations of in Class & Flipped class rooms
- Practical: Optical fiber: Determination of numerical aperture and acceptance angle.
- EL: Fiber optics & sensors

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

# MODULE VIII:

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Wave - particle duality - The Schrodinger equation - time dependent and independent equations - expectation values - particle in a box.

**SUGGESTED ACTIVITIES:**
- Illustration of potential wells and tunneling phenomena in class
- Flipped classroom
- EL – Wave - particle duality, Schrodinger equation, Particle in a box problem (1D, 2D, 3D)

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
### MODULE IX:

<table>
<thead>
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</table>

Crystal structures and packing factor (SC, BCC, FCC, Diamond) – Bragg’s law – determination of crystal structures.

**SUGGESTED ACTIVITIES:**
- Mostly in Class
- EL - Mini project for constructing crystal structures using softballs, Crystal structure parameters
- Practical: Crystal structures: Classification and packing factor, Modelling of Diamond crystal structure

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Project demonstration and presentation (crystal structures)

### MODULE X:

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</table>


**SUGGESTED ACTIVITIES:**
- Combination of in class & Flipped
- EL – Crystal growth techniques and IC process
- Practical: Post office box: Determination of band gap of a semiconductor
- Practical: Solution growth of crystal

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**REFERENCE BOOKS:**

**OUTCOMES:**
Upon completion of the course, the students will be able to:
- Apply appropriate concepts of physics to solve problems.
• Acquire knowledge on the basics of properties of matter, optics, lasers, crystals.
• Appreciate the importance of physics of materials for various engineering applications.

EVALUATION METHOD TO BE USED:

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<tr>
<th>Sl. no</th>
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MA6151 MATHEMATICS –I

<table>
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<td>• To gain proficiency in calculus computations.</td>
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<tr>
<td>• To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.</td>
</tr>
<tr>
<td>• To familiarize the student with functions of several variables.</td>
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<tr>
<td>• To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.</td>
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<td>• Applications in real life problems</td>
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<tr>
<td>• Assignment problems</td>
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<td>• Quizzes</td>
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### MODULE III  FUNCTIONS OF SEVERAL VARIABLES

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**SUGGESTED ACTIVITIES:**
- Problem solving sessions
- Applications in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE IV  MULTI VARIABLE DIFFERENTIAL CALCULUS

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**SUGGESTED ACTIVITIES:**
- Problem solving sessions
- Flipped Classroom

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE V  INTEGRAL CALCULUS

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**SUGGESTED ACTIVITIES:**
- Problem solving sessions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE VI  MORE ON INTEGRAL CALCULUS

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**SUGGESTED ACTIVITIES:**
- Problem solving sessions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

<table>
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Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves

**SUGGESTED ACTIVITIES:**
- Problem solving sessions
- Flipped Class room

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

<table>
<thead>
<tr>
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</table>

Triple integrals – Volume of solids – Change of variables in double and triple integrals.

**SUGGESTED ACTIVITIES:**
- Problem solving sessions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

<table>
<thead>
<tr>
<th>MODULE IX</th>
<th>L</th>
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</table>

Methods of variation of parameters – Method of undetermined coefficients -

**SUGGESTED ACTIVITIES:**
- Problem solving sessions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

<table>
<thead>
<tr>
<th>MODULE X:</th>
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</table>

Homogenous Equation of Euler’s And Legendre’s Type – System of Simultaneous Linear Differential Equations with Constant Coefficients.

**SUGGESTED ACTIVITIES:**
- Problem solving sessions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
OUTCOMES:
Upon completion of the course, the students will be able to:
- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXTBOOKS:

REFERENCES:

EVALUATION METHOD TO BE USED:

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Category of Courses</th>
<th>Continuous Assessment</th>
<th>Mid – Semester Assessment</th>
<th>End Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Theory</td>
<td>40</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Module I:</td>
<td>L</td>
<td>T</td>
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<td>EL</td>
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</tr>
<tr>
<td>Notion of memory, addresses, variables, instructions, execution of instructions. Operating system commands, file editing, compiling, linking, executing a program.</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
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**Suggested Activities:**
- Practical - Use of operating system commands and file editing operations.

**Suggested Evaluation Methods:**
- Exercises on the use of operating system commands and file editing operations.

<table>
<thead>
<tr>
<th>Module II:</th>
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<th>EL</th>
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<tbody>
<tr>
<td>Data types - constants, variables - arithmetic operators - expressions - basic input/output. Relational, logical, increment, decrement operators. Bitwise, assignment, conditional operators.</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
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</table>

**Suggested Activities:**
- EL - Programs using integer type, arithmetic operators and basic input/output.
- EL - Programs using other data types and operators.
- Practical - Demonstration of programs using integer type, arithmetic operators and basic input/output.
- Practical - Demonstration of programs using other data types and operators.

**Suggested Evaluation Methods:**
- Programs on integer type, arithmetic operators, basic input output.

<table>
<thead>
<tr>
<th>Module III:</th>
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</thead>
<tbody>
<tr>
<td>Statements and blocks - Selection - if-else construct - iteration - while - for constructs. The constructs else-if, switch, do-while, break, continue, enum. Pseudocode, Programming style.</td>
<td>2</td>
<td>1</td>
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</table>

**Suggested Activities:**
- EL: Programs using if-else, while, for.
- EL: Programs using else-if, switch, do-while, break, continue, enum. Use of pseudocode, programming style.
- Practical: Demonstration of programs using if else, while, for.
- Practical: Use of pseudocode. Demonstration of programs using else-if, switch, do-while, break, continue, enum, programming style.
**SUGGESTED EVALUATION METHODS:**
- Programs using if else, while, for.

<table>
<thead>
<tr>
<th>MODULE IV</th>
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</table>

Array, declaration, initialization. Multi dimensional arrays. Strings and character arrays, string operations on arrays.

**SUGGESTED ACTIVITIES:**
- EL - Programs using arrays and operations on arrays.
- Practical - Demonstration of programs using arrays and operations on arrays.
- EL - Programs implementing string operations on arrays.
- Practical - Demonstration of programs implementing string operations on arrays.

**SUGGESTED EVALUATION METHODS:**
- Evaluation: Programs using arrays and operations on arrays.
- Evaluation: Programs using strings and use of string library functions.
- Evaluation: Programs implementing string operations on arrays.

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<tr>
<th>MODULE V</th>
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**SUGGESTED ACTIVITIES:**
- EL - Programs using functions.
- Practical - Demonstration of programs using functions.
- EL - Programs using recursion.
- Practical - Demonstration of programs using recursion.

**SUGGESTED EVALUATION METHODS:**
- Evaluation: Programs using functions.
- Evaluation: Programs using recursion.

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<tr>
<th>MODULE VI</th>
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</tbody>
</table>

Pointers and arrays - address arithmetic. Dynamic Memory Allocation - Two dimensional arrays and pointers. Pointers and strings, string library functions. Pointers to functions.

**SUGGESTED ACTIVITIES:**
- EL - Programs using pointers and arrays, address arithmetic.
- Practical - Demonstration of programs using pointers and arrays, address arithmetic.
- EL - Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- Practical - Demonstration of programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- EL - Programs using Pointers and strings.
- Practical - Demonstration of programs using pointers and strings.

**SUGGESTED EVALUATION METHODS:**
- Evaluation: Programs on pointers and arrays, address arithmetic.
- Evaluation: Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- Evaluation: Programs using pointers and strings.
MODULE VII: L T P EL
| Structures, Structures and arrays. Pointers to structures, Self referential structures. Enumeration types, Unions, bit fields, typedefs. |
|---|---|---|---|
| 4 | 2 | 8 | 6 |

SUGGESTED ACTIVITIES:
- EL - Programs using structures and arrays.
- Practical - Demonstration of programs using Structures and arrays.
- EL - Programs using Pointers to structures, Self referential structures.
- Practical - Demonstration of programs using pointers to structures, Self referential structures.

SUGGESTED EVALUATION METHODS:
- Evaluation: Programs using Structures and arrays.
- Evaluation: Programs using pointers to structures, self referential structures.

MODULE VIII:

| Files - binary, text - open, read, write, random access, close. Preprocessor directives. Command line arguments. |
|---|---|---|---|
| 2 | 1 | 4 | 3 |

SUGGESTED ACTIVITIES:
- EL - Programs using file operations in real-world applications.
- Practical - Demonstration of real-world application using file operations.

SUGGESTED EVALUATION METHODS:
- Evaluation: Demonstration of real-world application.

TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Apply appropriate programming constructs to solve problems.
- Write C programs for simple applications.
- Use C pointers and dynamically allocated memory to solve complex problems.
- Know advanced features of the C programming language.
- Apply file operations to develop solutions for real-world problems.
CS6102    COMPUTATIONAL THINKING

Prerequisites for the course: None

OBJECTIVES:
- To formulate problems in a way that enables the use of a computer to solve them.
- To logically organize and analyze data.
- To automate solutions through algorithmic thinking.
- To identify, analyze and implement possible solutions with the goal of achieving the most efficient and effective combination of steps and resources.
- To generalize and transfer this problem solving process to a wide variety of problems.

MODULE I:

Algorithmic thinking - creating oral algorithms for everyday tasks - Data abstraction and representation - Abstraction and translation of everyday data for use on a computer.

SUGGESTED ACTIVITIES:
- Explore algorithm design by creating oral algorithms.
- Abstract the essential details of everyday objects.
- Translate the description of everyday objects into data types and variables.

SUGGESTED EVALUATION METHODS:
- Evaluation of the oral algorithms and computer data.

MODULE II:

Decomposing a complex problem - Strategies for decomposition and algorithm design - Divide and conquer - Simple program implementations.

SUGGESTED ACTIVITIES:
- Decompose a complex problem into discrete steps,
- Design a simple algorithm for solving the problem.
- External learning: Study of different strategies for decomposition and algorithm design.
- Examine sample input and expected output and develop strategies to decompose the problem.
- Use decomposition to break the problem into smaller problems and algorithmic design to plan a solution strategy.
- External learning: Simple program implementations.

SUGGESTED EVALUATION METHODS:
- Whiteboard presentations of the decomposition and algorithm.
- Evaluation of the developed strategies.
- Demonstration of the implemented programs.

**MODULE III:**

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Overall data representation, abstraction, analysis and algorithm design. Program implementations.

**SUGGESTED ACTIVITIES:**
- Examples of Data representation, abstraction, analysis and algorithm design.
- Programming implementation.

**SUGGESTED EVALUATION METHODS:**
- Whiteboard presentations of the Data analysis and Algorithm design.
- Demonstration of the programming implementations.

**MODULE IV:**

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**SUGGESTED ACTIVITIES:**
- Develop algorithms for sorting and determine the complexity of the algorithm and how it scales as the number of items to sort increases.
- Implement the different algorithms and measure how they scale.
- Determine which algorithms are more efficient, whether or not all algorithms are calculable given enough time.

**SUGGESTED EVALUATION METHODS:**
- Determine complexity of algorithms and how they scale with number of items.
- Demonstration using appropriate programs.
- Determine which algorithms are computable given enough time.

**MODULE V:**

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Enhancing the clarity of a program - documentation, style, idioms.

**SUGGESTED ACTIVITIES:**
- External Learning: Study the best practices of documentation, style, idioms, etc that are used to ensure the code can be understood and maintained over a long period.
- Use these practices in the documentation of earlier programs.

**SUGGESTED EVALUATION METHODS:**
- Documentation of given programs.

**MODULE VI:**

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Application of computational thinking to simple real world problems - program implementation of decomposed modules.

**SUGGESTED ACTIVITIES:**
• Application to simple real world problems.

SUGGESTED EVALUATION METHODS:
• Evaluation of the solutions to the real world problems

REFERENCES:
1. Exploring Computational Thinking.
   https://edu.google.com/resources/programs/exploring-computational-thinking/

OUTCOMES:
Upon completion of the course, the students will be able to:
• Abstract out details of data and represent them appropriately.
• Create appropriate algorithms to solve specified problems.
• Confidently deal with complexity and open-ended problems.
• Apply the computational thinking skills to real world problems.
• Use best practices for documentation that can ensure long term maintenance.

EVALUATION METHOD TO BE USED:

<table>
<thead>
<tr>
<th>Continuous assessment</th>
<th>Mid term</th>
<th>End Semester</th>
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<tr>
<td>60</td>
<td>40</td>
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<tr>
<td>MODULE 1 GIVING INSTRUCTIONS AND MAKING RECOMMENDATIONS</td>
<td>Oral Fluency: giving oral instructions and recommendations to carry out short processes. (e.g. how to maintain a smart phone)</td>
<td>Language Focus: use of imperatives and modal verbs (linguistic acts of instructing and recommending)</td>
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<td>Lexical Development: learning content-related vocabulary-derivatives-functional variations (use of affixes)-stress shift</td>
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<td>Reading Comprehension: language of advertising-(features)-passages discussing the uses of any particular product</td>
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<td>Listening- to a product description and listing the uses of the product</td>
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<td>Writing- designing an advertisement (language component of about 70-100 words)</td>
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<td>SUGGESTED ACTIVITIES</td>
<td>SUGGESTED EVALUATION METHODS</td>
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<td></td>
<td>• Lectures on the Communicative aspects of language use.</td>
<td>• Quizzes</td>
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<td>• Practical-Listening, Speaking and Writing</td>
<td>• Assignments</td>
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<td>• Small Group Work</td>
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<thead>
<tr>
<th>MODULE 2</th>
<th>ASKING AND ANSWERING QUESTIONS</th>
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<tbody>
<tr>
<td><strong>Oral Fluency:</strong> short conversations (informal) in academic institutions – Group discussions – Role play Activity</td>
<td><strong>Language Focus:</strong> speech acts (illocutionary force; making inferences) study of language in context- framing questions (asking &amp; answering questions) - <strong>Lexical Development:</strong> learning specialist vocabulary related to reading texts- <strong>Reading:</strong> dialogues and interviews (e.g. interviews with famous personalities)- <strong>Writing:</strong> dialogue writing-introduction to e-mail writing (personal)</td>
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<tr>
<td>At the end of the module, students should be able to:</td>
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<tr>
<td>• Participate in conversations in informal contexts</td>
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<tr>
<td>• Learn to use specialist vocabulary in appropriate contexts.</td>
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<tr>
<td><strong>SUGGESTED ACTIVITIES</strong></td>
<td><strong>SUGGESTED EVALUATION METHODS</strong></td>
</tr>
<tr>
<td>• Lectures on the Communicative aspects of language use.</td>
<td>• Quizzes</td>
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<tr>
<td>• Practical-Listening, Speaking and Writing</td>
<td>• Assignments</td>
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<td>• Small Group Work</td>
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<table>
<thead>
<tr>
<th>MODULE 3</th>
<th>ASKING AND ANSWERING QUESTIONS</th>
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<tbody>
<tr>
<td><strong>Oral Fluency:</strong> making power point presentations (modus operandi to be given)-debating skills- <strong>Language Focus:</strong> use of adjectival and adverbial forms- <strong>Lexical Development:</strong> content related vocabulary -Use of abbreviations and acronyms- <strong>Reading:</strong> passages on making presentations and making notes - preparation of slides- <strong>Writing:</strong> practice in note making and note taking- <strong>Listening</strong> – watching a presentation and completing a worksheet</td>
<td></td>
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<tr>
<td>At the end of the module, students should be able to:</td>
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<tr>
<td>• Make professional Power Point Presentations</td>
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<td>• Use note making and note taking skills effectively</td>
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<tr>
<td><strong>SUGGESTED ACTIVITIES</strong></td>
<td><strong>SUGGESTED EVALUATION METHODS</strong></td>
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Attested

Director
Centre for Academic Courses
Anna University, Chennai-600 025
<table>
<thead>
<tr>
<th>MODULE 4</th>
<th>ELABORATING ON ONE'S QUALIFICATIONS AND ACHIEVEMENTS</th>
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</table>

**Oral Fluency:** Oral Fluency: SWOT analysis - Role Play: going abroad for work assignments- Language Focus: active voice-use of punctuation marks-simple past and simple present perfect tenses- Lexical Development: specialist vocabulary (letter writing)- Reading – vision statement-work summary-job application-statement of purpose- Listening: listening to a talk and making notes- Writing: applying for a job (letter & e-mail) - bio data/resume

At the end of the module, students should be able to:
- Write a job application and draw a suitable bio data forms
- Read and understand the purposes of different types of writing

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<th>SUGGESTED ACTIVITIES</th>
<th>SUGGESTED EVALUATION METHODS</th>
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<tr>
<th>MODULE 5</th>
<th>WRITING PROJECT REPORTS</th>
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**Oral Fluency:** Asking and answering questions (e.g. discussion on training received in school/imaginary training programme) Language Focus: direct and indirect forms of narration-use of simple past and past continuous tense forms of verbs-use of modal verbs- formation of questions (interrogative and yes/no type of questions)-passive voice- Lexical Development: factual vs. emotive use of vocabulary-reporting verbs- Reading: industry /internship report-Writing: report on a training programme (model to be provided)

At the end of the module, students should be able to:
- Ask and answer different types of questions
- Write a purpose-oriented, factual, report
METHODS TO BE USED DURING CLASSROOM TEACHING

The following methods would be used to achieve programme objectives.

For language skills development:
1. Focus on fluency first for students with limited proficiency. Students would first develop the confidence to express themselves without being inhibited by errors.
2. Guided activities for speaking and writing with vocabulary and information provided as input.
3. Focus on simplicity and clarity than on the use of unnecessarily complex sentences and high-sounding words. Focus on clear organization of any spoken or written message.
4. Adequate preparation time given for demonstration of skills.
5. Sensitivity to issues of shyness and introversion and avoiding coercive methods.
6. Use of relevant techno-social topics on which students have opinion.
7. Use of listening and reading to improve vocabulary.
8. Peer evaluation using feedback templates to allow students to practice in small groups on their own. A session with 30 students needs to allow adequate opportunity to all students.
9. Teacher correction of individual writing scripts with feedback.

For communication skills development:
1. Focus on essential and time-tested principles of communication that are applicable in most contexts.
2. Avoiding formulae but providing basic templates that can be adapted to situations.
3. Avoiding complex behavioral theories or pop psychology as communication guides.
4. Using situations that students would typically encounter on campus and later at work.

<table>
<thead>
<tr>
<th>Listening:</th>
<th>to a report and completing a worksheet</th>
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<tbody>
<tr>
<td>SUGGESTED ACTIVITIES</td>
<td>SUGGESTED EVALUATION METHODS</td>
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<tr>
<td>Lectures on the Communicative aspects of language use.</td>
<td>Quizzes</td>
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<td>Practical-Listening, Speaking and Writing</td>
<td>Assignments</td>
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<td>Power Point Presentations</td>
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<td>Small Group Work</td>
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</table>
5. Gradual building of confidence by progressing from communication in front of small groups to communication in front of larger groups.

**ASSESSMENT**
Skills other than speaking would be tested using a paper and pencil test. Speaking skills will be tested using a verbal test.

**TEXTBOOK:**

**REFERENCES:**

**EVALUATION METHOD TO BE USED:**

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Category of Courses</th>
<th>Continuous Assessment</th>
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<td>Theory</td>
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**MODULE I:**
Polymer Chemistry: Introduction: Functionality; Classification of Polymers- Natural and Synthetic, Thermoplastic and Thermosetting. Types and Mechanism of Polymerization: Addition (Free Radical, Cationic, Anionic and Living); Condensation and Copolymerization. Piezo and pyro electric polymers; Photoresists – Positive and negative.

**SUGGESTED ACTIVITIES:**
- In Class activity for Functionality and Mechanism of polymerisation
- Practical – Thermal free radical polymerisation of styrene/MMA

**SUGGESTED EVALUATION METHODS:**
- Tutorial: Deduce type of polymer from monomers with different functionalities
- Assignment: Predicting mechanism of polymerization for few important monomers
- Quizzes

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<th>MODULE II</th>
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Properties of Polymers: $T_g$, Tacticity, Degree of Polymerization & Molecular Weight - Weight Average, Number Average and Polydispersity Index. Techniques of Polymerization: Bulk, Emulsion, Solution and Suspension

**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- Proofs and Simplification in class
- Practical – Determination of molecular weight of PVA using Ostwald viscometer

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Evaluate quantum efficiency for different systems
- Photo Processes – in class and EL based on that
- Practical – Estimation of sodium in water sample by flame photometry

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Spectroscopy: Absorption of Radiation-Electronic, Vibrational and Rotational Transitions. Width and Intensities of Spectral Lines. Spectrophotometric Estimation Of Iron. UV-Vis and IR Spectroscopy-Principles, Instrumentation (Block Diagram) and Applications

**SUGGESTED ACTIVITIES:**
- Flipped Class room
- Types of electronic/vibrational transitions for different molecules – in class and EL based on that
- Practical – Estimation of iron in water sample by spectrophotometry
**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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<th>MODULE V</th>
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</table>

**SUGGESTED ACTIVITIES:**
- Industrial applications in class
- EL – Adsorption of gases on solids
- Practical – Adsorption of acetic acid/oxalic acid on charcoal – verification of Freundlich’s adsorption isotherm.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment
- Quizzes

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<tbody>
<tr>
<td>Catalysis: Characteristics and Types of Catalysts-Homogeneous and Heterogeneous, Auto Catalysis. Enzyme Catalysis - Factors Affecting Enzyme Catalysis, Michaelis - Menton Equation. Industrial Applications of Catalysts</td>
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</table>

**SUGGESTED ACTIVITIES:**
- Introduction in class
- Analysis in Class
- Flipped Classroom for further study
- Practical – Determination of rate constant of acid catalysed hydrolysis of an ester

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment
- Quizzes

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</table>

**SUGGESTED ACTIVITIES:**
- Combinations of in Class & Flipped class rooms
- Practical – Phase change in a solid.
- EL - HDL descriptions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems


- Assignment problems
- Quizzes

### MODULE VIII:

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**SUGGESTED ACTIVITIES:**
- Combinations of in Class & Flipped class rooms
- EL – Properties and uses of Nanowires, nanoclusters, nanorods, nanowires
- Practical – Preparation of nano wire by electrospinning

**SUGGESTED EVALUATION METHODS:**
- Tutorial
- Assignment
- Quizzes

### MODULE IX:

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Fabrication of integrated circuits: Introduction – Fabrication – MOS – NMOS, PMOS, CMOS, Ga-As Technologies, Printed circuit boards-Fabrication (Single layer only) – Lamination, printing (photo and screen printing) and mechanical operation.

**SUGGESTED ACTIVITIES:**
- Mostly in Class
- EL - Mini project for Lamination by Hand lay up Technique
- Practical – Determination of total, temporary and permanent hardness of water by EDTA method

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Project demonstration and presentation

### MODULE X:

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**SUGGESTED ACTIVITIES:**
- Combination of in class & Flipped

**SUGGESTED EVALUATION METHODS:**
- Tutorial
- Assignment
- Quizzes
PREREQUISITES FOR THE COURSE:
Laboratory facilities to carry out the experiments mentioned in each of the modules –
Thermal free radical polymerisation of styrene/MMA, Determination of molecular weight of PVA using Ostwald viscometer, Estimation of sodium in water sample by flame photometry, Estimation of iron in water sample by spectrophotometry, Adsorption of acetic acid/oxalic acid on charcoal – verification of Freundlich’s adsorption isotherm, Determination of rate constant of acid catalysed hydrolysis of an ester, Phase change in solid, Electrospinning, Total and temporary hardness.

OUTCOMES
Upon completion of the course, the students will be able to:
- Identify the different types of polymers, polymerisation processes and some special properties and applications of polymers.
- Identify suitable adsorbents/adsorption process and catalysts for pollution abatement and other industrial processes.
- Discuss the concepts involved in the absorption of radiation by materials and various photophysical processes, polymer chemistry, surface chemistry and catalysis.
- Point out the spectral techniques for qualitative and quantitative analysis & thermodynamics of various processes.
- Discuss the importance of the nano materials (and their superiority over conventional materials), feasibility of their preparation and uses
- Elaborate on various technologies for the fabrication of integrated circuits & specialty materials in the electronics/electrical industry

TEXT BOOKS:

REFERENCES:

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Centre for Academic Courses
Anna University, Chennai-600 025
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**MODULE I  LOGIC**

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**SUGGESTED ACTIVITIES:**
- Problem Solving sessions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE II  PROOFS**

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**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Applications in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE III  COMBINATORICS**

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**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Applications in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE IV  RECURRENCES**

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**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Applications in real life problems

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SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton paths.

SUGGESTED ACTIVITIES:

- Problem Solving sessions
- Flipped class room
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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Algebraic systems – Semi groups and monoids – Groups - Subgroups - Homomorphisms

SUGGESTED ACTIVITIES:

- Problem Solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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Normal subgroup and coset - Lagrange”s theorem – Definitions and examples of Rings and Fields

SUGGESTED ACTIVITIES:

- Problem Solving sessions
- Flipped Class room

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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Partial ordering – Posets – Lattices as Posets – Properties of lattices - Lattices as algebraic systems – Sub lattices

SUGGESTED ACTIVITIES:

- Problem Solving sessions
Applications in real life problems

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX BOOLEAN ALGEBRA

Direct product and Homomorphism – Some special lattices – Boolean algebra

SUGGESTED ACTIVITIES:
- Problem Solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

OUTCOMES:
Upon completion of the course, the students will be able to:
- Identify techniques to test the logic of a program.
- Identify structures at many levels.
- Work with a class of functions which transform a finite set into another finite set which relates to input and output functions in Computer Science.
- Discuss the counting principles.
- Point out the properties of algebraic structures such as groups, rings and fields.

TEXT BOOKS:

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**OBJECTIVES**

- To develop in students, graphic skills for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.

**SUGGESTED ACTIVITIES :**

- Demonstration using CAD software to bring out the concepts presented in the subject
- Hands on practicals on open source software

**SUGGESTED EVALUATION METHODS:**

- Quizzes

**MODULE II**

Basic Geometrical Constructions, Curves used in Engineering Practices - Conics – Construction of Ellipse, Parabola and Hyperbola by Eccentricity Method – Construction of Involutes of Square and Circle – Drawing of Tangents and Normal to the above Curves.

**SUGGESTED ACTIVITIES :**

- Videos of application of Geometric curves in various domains
- Theory and mathematics in class
- EL – Practical Problems
- Practical – Construction of curves

**SUGGESTED EVALUATION METHODS:**

- Tutorial problems
- Assignment problems
- Quizzes

**MODULE III**

Visualization Concepts and Free Hand Sketching: Visualization Principles – Representation of Three Dimensional Objects – Layout of Views - Free Hand Sketching of Multiple Views from Pictorial Views of Objects

**SUGGESTED ACTIVITIES :**

- Building models using various media
- Discussing uses of multiple views in various fields
- Practical - Construction of 3D views

**SUGGESTED EVALUATION METHODS:**

- Tutorial problems
- Assignment problems
- Quizzes

**MODULE IV**

Orthographic Projection - Principles - Principal Planes - First Angle Projection - Projection of Points. Projection of Straight Lines (only First Angle Projections) Inclined to Both the Principal Planes.
### Determination of True Lengths and True Inclinations by Rotating Line Method and Trapezoidal Method and Traces

**SUGGESTED ACTIVITIES:**
- Videos of application of projections in various domains
- Theory and mathematics in class
- EL – Practical Problems in orthographic projection of points
- Practical – Construction of curves

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Projection of Planes (Polygonal and Circular Surfaces) Inclined to both the Principal Planes by Rotating Object Method.

**SUGGESTED ACTIVITIES:**
- Videos of application of projections in various domains
- Theory and mathematics in class
- EL – Practical Problems in orthographic projection of planes

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Projection of Simple Solids like Prisms, Pyramids, Cylinder, Cone and Truncated Solids when the Axis is Inclined to both the Principal Planes by Rotating Object Method and Auxiliary Plane Method.

**SUGGESTED ACTIVITIES:**
- Introduction in class
- Models making
- Videos/software demonstrations

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Sectioning of Solids in Simple Vertical Position when the Cutting Plane is Inclined to the one of the Principal Planes and Perpendicular to the other – Obtaining True Shape of Section.

**SUGGESTED ACTIVITIES:**
- Introduction in class
- Models
- Videos/software demonstrations

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
Assignment problems  
Quizzes

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**SUGGESTED ACTIVITIES:**
- Development models in cardboard
- Software demonstration

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Videos
- Demonstrations using Solid modeling software

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Videos
- Illustration using Advertisements

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**OUTCOMES:**

Upon completion of the course, the students will be able to:
- Perform free hand sketching of basic geometrical shapes and multiple views of objects.
- Draw orthographic projections of lines, planes and solids
- Obtain development of surfaces.
- Prepare isometric and perspective views of simple solids.
TEXT BOOK:

REFERENCES:

Publication of Bureau of Indian Standards:

EVALUATION METHOD TO BE USED:

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</table>
OBJECTIVES:

- To introduce students to programming languages and techniques associated with the world wide web and thereby create interest in programming even to students with little programming knowledge
- To introduce tools for creating interactive web pages
- To introduce the client-server architecture
- To introduce databases

MODULE I:

Design of webpages – Use of Cascading style sheets to style the way a webpage looks

SUGGESTED ACTIVITIES:

- EL – Learn to use CSS

SUGGESTED EVALUATION METHODS:

- Demonstration of designed webpages
- Evaluation of the preparation done in learning CSS syntax

MODULE II:

Incorporating multimedia into a webpage (Text / Audio / Image / Video / Animation)

SUGGESTED ACTIVITIES:

- EL – Learn how to read information from a file/array and display on the webpage

SUGGESTED EVALUATION METHODS:

- Demonstration of having incorporated multimedia in a webpage

MODULE III:

Writing client side scripts using Javascript / Angular JS
Client side validation

SUGGESTED ACTIVITIES:

- EL – Learn to use Javascript / Angular JS

SUGGESTED EVALUATION METHODS:

- Demonstration of using client side validation for designed web browsers

MODULE IV:

Designing a static website using content management frameworks

SUGGESTED ACTIVITIES:

- EL – Familiarity with any one content management framework

SUGGESTED EVALUATION METHODS:

- Evaluation of the preparation done in getting familiarized with a content management framework

MODULE V:

Understanding servers – Server login, Database connectivity

SUGGESTED ACTIVITIES:

- EL- Overview of databases
SUGGESTED EVALUATION METHODS:
- Quiz on servers and overview of databases

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Use queries for fetching from database
Processing the results of queries
File upload/download
File streaming

SUGGESTED ACTIVITIES:
- EL - SQL queries to create table, select, update and insert

SUGGESTED EVALUATION METHODS:
- Quiz on SQL queries
- Demonstration of the use of queries

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Server side scripts and validation

SUGGESTED ACTIVITIES:
- EL – Learn how to write server side scripts

SUGGESTED EVALUATION METHODS:
- Demonstration of the use server side scripts

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Development of web application

SUGGESTED ACTIVITIES:
- EL - Select an application for which webpage has to be developed. List the features to be included.

SUGGESTED EVALUATION METHODS:
- Oral explanation of the web application to be developed

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Development of web application

SUGGESTED ACTIVITIES:
- EL – Application of what was learnt in the previous weeks and develop the webpage

SUGGESTED EVALUATION METHODS:
- Demonstration of developed web application

OUTCOMES:
Upon completion of the course, the students will be able to:
- Develop interactive websites
- Use of databases
- Understand and appreciate the use of the client-server architecture
REFERENCES:

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CS6104 DATA STRUCTURES AND ALGORITHMS

Prerequisites for the course: NIL

OBJECTIVES:
- To understand the concepts of linear and non-linear data structures
- To get an idea about suitability of data structure for an application
- To learn some fundamental algorithm design strategies
- To understand how the correctness of an algorithm can be proved
- To learn how to analyze an algorithm
- To understand the concept of NP-Completeness

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SUGGESTED ACTIVITIES:
- Workout on design of algorithms for some small simple problems, provide proof of correctness, and determine the complexity.
- EL - Study on average case analysis for some standard algorithms.

SUGGESTED EVALUATION METHODS:
- Assignment - Based on design, correctness and efficiency.
MODULE II  LINEAR DATA STRUCTURES

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Stack - Queue - Linked lists - Some applications based on linear data structures.

**SUGGESTED ACTIVITIES:**
- EL – Converting an algorithm from recursive to non-recursive using stack.
- Practical - An application based on linear data structure.

**SUGGESTED EVALUATION METHODS:**
- Programming exercises in the laboratory
- Quizzes

MODULE III  NON-LINEAR DATA STRUCTURES

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Trees - Graphs - Traversals - Threaded binary trees.

**SUGGESTED ACTIVITIES:**
- EL - Applications of trees and graphs.
- Practical - Implementing tree and graph traversals.

**SUGGESTED EVALUATION METHODS:**
- Assignment related to application
- Programming exercises in the laboratory
- Quizzes

MODULE IV  DIVIDE & CONQUER

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Strassen’s Matrix Multiplication - Selection in Linear Time.

**SUGGESTED ACTIVITIES:**
- EL – Merge Sort & Quick Sort
- Practical – Implementation of Merge Sort & Quick Sort.

**SUGGESTED EVALUATION METHODS:**
- Programming exercises in the laboratory
- Assignment problems
- Quizzes

MODULE V  GREEDY METHOD

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**SUGGESTED ACTIVITIES:**
- EL – Tree Vertex Splitting
- Practical – Spanning Tree Implementation

**SUGGESTED EVALUATION METHODS:**
- Programming exercises in the laboratory
- Quizzes

MODULE VI  DYNAMIC PROGRAMMING

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Principles of Optimality - Matrix chain multiplication - Longest common subsequences

**SUGGESTED ACTIVITIES:**
- EL – All Pair shortest path.
- Practical - Implementation of All pair shortest path

**SUGGESTED EVALUATION METHODS:**
- Programming exercises in the laboratory
- Quizzes

**MODULE VII** BACKTRACKING & BRANCH AND BOUND

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Backtracking: 8-Queens & Sum of subsets – Branch & Bound: 0/1 Knapsack

**SUGGESTED ACTIVITIES:**
- Flipped class rooms
- Practical - Implementations of sum of subset problem.
- EL – Travelling Salesperson using Branch & Bound

**SUGGESTED EVALUATION METHODS:**
- Programming exercises in the laboratory
- Assignment problems
- Quizzes

**MODULE VIII** MORE ON SORTING & INDEXING

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Heap Sort – External sorting – Hashing

**SUGGESTED ACTIVITIES:**
- EL – Comparison of internal sorting algorithms
- Practical – Implementation of Hash table

**SUGGESTED EVALUATION METHODS:**
- Programming exercises in the laboratory
- Quizzes

**MODULE IX** STRING MATCHING

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Naïve Algorithm – KMP Algorithm

**SUGGESTED ACTIVITIES:**
- Tutorial
- Practical – Implementation of KMP algorithm

**SUGGESTED EVALUATION METHODS:**
- Programming exercises in the laboratory
- Quizzes

**MODULE X** NP-COMPLETENESS

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Polynomial time verification – Theory of reducibility - NP Completeness proof for Vertex cover & Hamiltonian Cycle.

**SUGGESTED ACTIVITIES:**
- EL – Study of proof for NP completeness on any two problems

**SUGGESTED EVALUATION METHODS:**
- Quizzes
TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Point out various representations of data structures
- Write functions to implement linear and non–linear data structure operations
- Suggest and use appropriate linear/non–linear data structure operations for solving a given problem
- Apply various algorithm design techniques and analysis
- Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval
- Show how to prove a problem to be NP-Complete

Evaluation Pattern:

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CS6105 DIGITAL FUNDAMENTALS AND COMPUTER ORGANIZATION
Prerequisites for the course: None

OBJECTIVES:
- To learn Boolean algebra and simplification of Boolean functions

50
• To learn to design and analyze different combinational circuits
• To study the basics of synchronous sequential logic and analyze and design sequential circuits
• To understand the important components of a computer system and the basic organization
• To learn to write code in hardware description languages for designing larger digital systems

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**MODULE I:**
Number Systems – Binary, Octal, Hexadecimal – Representation of negative numbers - 1’s and 2’s Complements - Arithmetic Operations – Binary Codes.

**SUGGESTED ACTIVITIES:**
- In Class activity for place - value systems
- Practical – Abacus – Counting – Activity

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE II:**
Boolean Algebra – Theorems and Postulates - Functions – Truth Table - Logic Gates – Universal gates

**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- Proofs and Simplification in class
- EL – Practical Problems - Introduction to propositional problems using conjunction, disjunction and negation
- Practical - Implementation of simple functions using gates

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE III:**
Canonical and Standard Forms – Minterms and Maxterms - Sum of Products and Product of Sums - Simplification of Boolean Functions - Karnaugh Map – 2,3,4 variables - NAND / NOR Implementations.

**SUGGESTED ACTIVITIES:**
- EL - Exclusive OR function
**Practical - Simplification and implementation of Boolean functions**

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Flipped Class room
- Introduction to HDL – in class and EL based on that
- Practical - Implementation of the arithmetic circuits and getting started with HDL

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Decoder, Encoder, Priority Encoder, Mux/Demux - Applications. HDL for these circuits.

**SUGGESTED ACTIVITIES:**
- Applications in class
- EL – HDL for these combinational circuits
- Practical - Implementation of these circuits and HDL implementations

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Introduction in class
- Analysis in Class
- Flipped Classroom for further study
- Practical - Implementation of Flip flops

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
### MODULE VII:
**Registers** – Shift Registers, Universal Shift Register Counters – Ripple Counters, Synchronous Counters, Ring Counter, Johnson Counter - HDL for counters and shift registers

**SUGGESTED ACTIVITIES:**
- Combinations of in Class & Flipped class rooms
- Practical - Implementations of counters and shift registers
- EL - HDL descriptions
- EL - Mini project for designing and implementing a digital system using both hardware and software (HDL)

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE VIII:
**Practical Problems in Sequential design** – Timing diagrams - Problems combining Combinational & Sequential Components – State reduction – State Assignment

**SUGGESTED ACTIVITIES:**
- Timing diagrams in class
- Flipped classroom
- Practical - HDL descriptions to be continued

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE IX:
**Memory Systems** – RAM, ROM, PLD, PLA and PAL - Design of digital systems

**SUGGESTED ACTIVITIES:**
- Combination of in class & Flipped
- Practical - Project demonstration and presentation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE X:
**Basic Components of a digital computer** - Functions - Organization - Instruction Execution - Data path and control path

**SUGGESTED ACTIVITIES:**
- Mostly in Class
- Practical - Project demonstration and presentation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Simplify complex Boolean functions
- Design and analyze digital circuits with combinational and sequential components
- Implement digital circuits using MSI chips and PLDs
- Use HDL to build digital systems
- Point out the basic functionalities of the components of a digital computer and their organization

EVALUATION PATTERN:

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MA6351 PROBABILITY AND STATISTICS

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OBJECTIVES:
- To provide students with the basic concepts of probability theory
- To equip the students with essential tools for statistical analyses at the graduate level.
- To Foster understanding through real-world statistical applications.

MODULE I RANDOM VARIABLES

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</table>
### Discrete and Continuous Random Variables – Moments – Moment Generating Functions

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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<th>MODULE II</th>
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- Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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<thead>
<tr>
<th>MODULE III</th>
<th>TWO - DIMENSIONAL RANDOM VARIABLES</th>
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- Joint distributions – Marginal and conditional distributions

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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- Covariance – Correlation and Linear regression

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
### MODULE V  
**TRANSFORMATION OF RANDOM VARIABLES**

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Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE VI  
**TESTING OF HYPOTHESIS (Large Samples)**

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Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means.

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE VII  
**TESTING OF HYPOTHESIS (Small Samples)**

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Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE VIII  
**DESIGN OF EXPERIMENTS**

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Analysis of variance – One way and two-way classification – Completely Random Design.

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE IX  STATISTICAL QUALITY CONTROL**

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Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts)

**SUGGESTED ACTIVITIES:**
- Problem Solving sessions
- Seminar by students
- Application in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**OUTCOMES:**
Upon completion of the course, the students will be able to:
- Use statistical methodology and tools in the engineering problem-solving process
- Describe the properties of discrete and continuous distribution functions
- Use method of moments and moment generating functions
- Compute point estimation of parameters
- Apply the Central Limit Theorem
- Use statistical tests in testing hypotheses on data

**TEXT BOOKS:**

**REFERENCES:**

**Evaluation Pattern:**
<table>
<thead>
<tr>
<th>Category of Course</th>
<th>Continuous Assessment</th>
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**EE6351 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**Prerequisites for the course: None**

**OBJECTIVES:**
- To learn the steady state DC and AC characteristics of electric circuits
- To understand the working of DC/AC motors, transformer and generators
- To understand the functionality of basic electronic circuits namely amplifiers, filters, data converters and oscillators
- To learn the design aspects of basic amplifier configurations and concepts of feedback techniques

**MODULE I:**

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**SUGGESTED ACTIVITIES:**
- Computer simulation of DC circuits problems and solution
- EL- Solving of complex electrical networks using circuit theorems
- Practical – Basic electrical circuit measurements and verification of circuit theorems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE II:**
### Introduction to AC Circuits – Sinusoidal steady state analysis – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

**SUGGESTED ACTIVITIES:**
- Computer simulation of AC circuits problems and solution
- EL - Solving of other engineering problems as electrical circuit equivalents
- Practical – Three phase power measurements

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors

**SUGGESTED ACTIVITIES:**
- EL- Survey of commonly used DC machines and their applications
- Practical – Load test on DC motor and generator

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Operating principle of Transformers – Induction Motor – single phase and three phase operation, Stepper motor

**SUGGESTED ACTIVITIES:**
- Study of utility power grid and the use of transformers
- EL- Survey of commonly used AC machines and their applications
- Practical – Load test on transformer and Induction motor

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Practical - V- I characteristics of PN Junction and Voltage regulator characteristic of Zener Diode,
- Demonstration - Half wave and Full wave Rectifiers
### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Elementary Treatment of Small Signal Amplifier – Linear Amplifier, Biasing Requirement – Voltage Divider Biasing, Basic CE amplifier circuit - Small signal equivalent model - Small signal Voltage gain

### SUGGESTED ACTIVITIES:
- Practical – CE amplifier Voltage Divider Biasing and verification of operating point, Verification of small signal voltage gain

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Differential amplifier using BJT, Negative feedback amplifier – characteristics – topologies, Opamp - inverting amplifier - non inverting amplifier.

### SUGGESTED ACTIVITIES:
- Practical - Opamp characteristics: Verification of inverting amplifier gain Verification of non inverting amplifier gain

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Opamp based circuit – Summer – Subtractor – Integrator – Differentiator, Opamp based Filters – Low pass, High pass, Band pass, Band reject.

### SUGGESTED ACTIVITIES:
- Practical -Verification of opamp based arithmetic circuit Verification of frequency response characteristics of opamp based First order lowpass filter,First order highpass filter

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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SUGGESTED ACTIVITIES:
- Presentation / Assignment on Performance metrics of ADC
- Ring oscillator circuit architecture

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE X:

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MOSFET – V-I characteristics, MOSFET small signal equivalent circuit, Common Source amplifier – Voltage gain – Frequency response characteristic.

SUGGESTED ACTIVITIES:
- Spice simulation - MOSFET V-I characteristic

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

OUTCOMES:
Upon completion of the course, the students will be able to:
- Compute steady state solution of DC and AC electric circuits
- Analyze the characteristics of motors and transformers
- Design and analyze amplifiers
- Characterize the frequency response of BJT based amplifiers
- Realize arithmetic circuits, basic filter configurations using opamp
- Point out the characteristics of data converters

TEXT BOOKS:

REFERENCES:
Evaluation Pattern:

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CS 6106 DATA BASE MANAGEMENT SYSTEMS

Pre-requisites for the course: None

OBJECTIVES:
- To learn the fundamentals of data models and to conceptualize and represent a database system using ER diagram
- To study the principles to be followed to create an effective relational database design and effectively write SQL queries to retrieve/store data from/to database
- To know the fundamental concepts of transaction processing-concurrency control techniques and recovery procedure
- To have an introductory knowledge about the storage and query processing techniques and the basic concepts of Information retrieval techniques
- To learn about the internal storage structures using different file and indexing techniques which will help in physical DB design

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MODULE I:

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<tr>
<th>Introduction to Databases- File System Vs Database System - Data Models- Schemas and Instances - DBMS Architecture- Centralized - Client Server - Database Applications</th>
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</table>

SUGGESTED ACTIVITIES:
- In class activity for various database applications
### SUGGESTED EVALUATION METHODS:
- Tutorial: scenarios to analyze the need for DB in various applications
- Practical - Installation of Open Source DBMS software and perform basic DB operations like creating sample tables and populating the instances
- Quizzes

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Entity Relationship (ER) Model - conceptual design of DB Application - ER diagram - Design issues - Relationship types - other notations - Extended Entity-Relationship (EER) Model - ER to Relational Mapping

### SUGGESTED ACTIVITIES:
- In class activity: defining the participating entities and their relations for a given scenario
- Practical –Use OSS to draw the ERD depicting the attributes, cardinality and other relationships

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Relational Data Model - Operations on Relational Model - Specifying Constraints Relational Algebra - Unary, Binary, Set and other Operations - Tuple and Domain Relational Calculus. SQL - Data Definition - Data Manipulation and Retrieval Queries

### SUGGESTED ACTIVITIES:
- In Class - ER Model to Relational Model mapping
- Practical - ER Modeling using open source tools and Schema realization

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Database Design - Functional Dependencies - Normal Forms - 1 NF - 2 NF - 3 NF - BCNF - Multivalued Dependency - Join Dependency

### SUGGESTED ACTIVITIES:
- In Class - Normalization
- Flipped class room - Database design validation through Normalization, Understanding the functional dependency across the attributes in the relation.
- Practical – Creation of schema using Data Definition language and Instances using the Data Manipulation language commands
- Practical – Simple SQL query construction using keywords

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes
### Complex SQL Queries - Nested Queries - Correlated Nested Queries - Various Types of Joins - Aggregate Functions - Grouping - Triggers – Views – Embedded and Dynamic SQL

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<th>SUGGESTED ACTIVITIES:</th>
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<tbody>
<tr>
<td>• In Class - SQL Queries and Joins</td>
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<tr>
<td>• Practical - Implementation of complex SQL Queries (Joins, Sub queries, inbuilt functions) and Triggers</td>
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<td>• EL – Understand the features in other commercial or open-source DBMS</td>
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Transaction processing concepts -Need for concurrency control and recovery- ACID Properties - Recoverability - Serializability

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<tr>
<td>• In Class –examples to understanding the real-world scenarios like concurrency in transactions</td>
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<tr>
<td>• Practical - Implementation of complex procedures (PL/SQL Procedures) and transactions involving shared variables</td>
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Concurrency Control - Two phase locking Techniques - Timestamp Ordering - Granularity - Recovery - Deferred Update - Immediate Update - Deadlocks

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<td>• In Class – examples to understanding the real-world scenarios like concurrency, deadlock and recovery in transactions</td>
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<td>• Practical - Implementation of complex procedures (PL/SQL functions) and transactions involving shared variables</td>
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Query Processing - SQL Query Translation - Pipelining - Query Optimization - Cost Estimation - Semantic Query Optimization

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<tr>
<td>• EL – Methods for optimizing the query in terms of space and time complexity</td>
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<tr>
<td>• In Class - Query Translation and Optimization</td>
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<tr>
<td>• Flipped classroom - cost-based query optimization for complex SQL queries</td>
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<td>• Practical – Cost estimation for a query using OSS</td>
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SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX:

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Indexing - Single-Level and Multilevel Index - Multiple Key Index - Indexing Issues - Hashing

SUGGESTED ACTIVITIES:
- EL – efficient methods for storage and retrieval
- In Class - Selecting the Index types for a scenario and discuss the efficiency
- Flipped Classroom – Issues on selection of attribute in a relation for Indexing / Hashing
- Practical – Use OSS to compare the efficiency of the various available methods of storage and retrieval

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE X:

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Introduction to Database Tuning - Data Warehousing and Mining – Spatial and Temporal Databases – OO Databases, NoSQL

SUGGESTED ACTIVITIES:
- EL – Applications that use Spatial and temporal data
- In Class – Analyzing the tuning parameters that corresponds to high performance.
- Flipped Classroom – Demonstrate the operations on Data in Data warehouse & mine specific patterns
- Practical – Use OSS to perform the operations in DW & M

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Project demonstration and presentation

OUTCOMES:

Upon completion of the course, the students will be able to:
- Model an application’s data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model
- Formulate solutions to a broad range of query problems using relational algebra/ SQL
- Demonstrate an understanding of normalization theory and apply such knowledge to the normalization of a database
- Run transactions and estimate the procedures for controlling the consequences of concurrent data access
- Discuss the basic database storage structures and access techniques: file and page organizations, indexing methods including B-tree, and hashing
- Point out the basics of query evaluation techniques and query optimization

65
TEXT BOOKS

REFERENCES:

EVALUATION METHOD TO BE USED:

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CS 6107 COMPUTER ARCHITECTURE

Prerequisites for the course: None

OBJECTIVES:
- To identify the requirements of different types of computer systems
- To understand the evaluation of computer systems based on various performance metrics
- To study the characteristics of the ISA and the hardware software co-design
- To trace the execution sequence of an instruction through the processor
- To compare different approaches used for implementing a functional unit
- To understand the fundamentals of memory and I/O systems and their interaction with the processor
MODULE I:

Introduction - Classes of computer systems - Performance - Amdahl’s law - The Power wall - Switch from uniprocessors to multiprocessors – Benchmarks.

SUGGESTED ACTIVITIES:
- In Class activity for performance evaluation
- EL - Evolution of computer systems, identification of benchmarks
- Practical – Demonstration - Opening up a computer system and studying the components

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

MODULE II:

Hardware Software Interface - ISA - Operations of the computer hardware - Operands - Representing instructions - Instructions for making decisions - Supporting procedures in computer hardware.

SUGGESTED ACTIVITIES:
- Flipped classroom and activity
- EL – Writing simple assembly language programs from high level code
- Practical – Study of an existing standard architectural simulator

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

MODULE III:

Addressing modes - Translating and starting a program - Arrays versus pointers - MIPS instruction formats - Assembly language programming.

SUGGESTED ACTIVITIES:
- EL - Familiarising with assembly language programming
- Practical - Study of an existing standard architectural simulator

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

MODULE IV:

Integer arithmetic - Binary Parallel adder – Carry Look-ahead Adder - Carry save adder - Binary multiplier - Booth’s multiplier - Bit-pair recoding - Binary division.

SUGGESTED ACTIVITIES:
- Flipped Class room
- Some arithmetic algorithms in class and some as EL
- Practical : Study of addressing modes with examples, Tracing the execution sequences, Identifying the timing constraints
SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Floating point arithmetic - Representation - Arithmetic operations on floating point numbers - Parallelism and computer arithmetic.

SUGGESTED ACTIVITIES :
- Flipped class room
- EL – Simulation of the floating point operations
- Practical - Study of the ISA supported by the architectural simulator and running simple programs on the simulator

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes
- Demonstrate decode and execute for a subset of instructions on the simulator

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Datapath design - Implementation of the basic MIPS ISA - Building the datapath - A simple implementation scheme - Drawbacks.

SUGGESTED ACTIVITIES :
- Introduction in class
- Flipped Classroom for building of datapath for additional instructions
- Practical - Analysing the datapath on the standard simulator

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quiz in Class or automatic Quizzes for the flipped classroom content

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Instruction Level Parallelism - Pipelining - Overview of pipelining - Performance - Pipeline hazards - Pipelined datapath and control - Handling data hazards and control hazards - Exceptions - Introduction to advanced ILP.

SUGGESTED ACTIVITIES :
- Combinations of in Class & Flipped class rooms
- Practical - Study of the pipelined implementation and analysis of various hazards on the standard simulator

SUGGESTED EVALUATION METHODS:
- Assignment problems involving instruction sequences and real-time scenarios
- Quizzes

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to virtual machines.

**SUGGESTED ACTIVITIES:**

- Flipped classroom
- Practical - Implement a simple functional model of a set-associative cache in C/C++. Study hit/miss rates for various access patterns. Experiment with different replacement policies.
- EL - Writing simple programs to study the behaviour of the memory hierarchy of your own laptop/PC
  - Analyzing the performance of the memory hierarchy by varying different parameters

**SUGGESTED EVALUATION METHODS:**

- Assignment problems
- Quizzes
- Practical component evaluation

**MODULE IX:**

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Storage and I/O - Dependability, reliability and availability - Disk storage - Flash storage - Connecting processors, memory and I/O devices - Interfacing I/O devices to the processor, memory and the operating system, Designing an I/O system, Parallelism and I/O, RAID.

**SUGGESTED ACTIVITIES:**

- EL - Survey of storage devices (NAS/SAN/RAID etc.) on different classes of systems
- Practical – Continue with the exercises on memory hierarchy

**SUGGESTED EVALUATION METHODS:**

- Survey evaluation – mindmap

**OUTCOMES:**

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

- Evaluate the performance of computer systems
- Design a simple instruction execution unit
- Point out the hazards present in a pipeline and suggest remedies
- Explain the data path and control path implementation of a processor
- Modify some features of an architectural simulator
- Critically analyse the various characteristics of the hierarchical memory and I/O devices and their interface to the processor

**TEXT BOOKS:**


**REFERENCE BOOKS:**


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CS 6108 OPERATING SYSTEMS

Prerequisites for the course: None

OBJECTIVES:
- To learn the basic concepts and functions of operating systems
- To learn the mechanisms of operating systems to handle processes and threads and their communication
- To know the components and management aspects of concurrency management
- To study the basic components of scheduling mechanism
- To learn the mechanisms involved in memory management in contemporary OS
- To appreciate the emerging trends in Operating Systems
- To learn programmatically to implement simple OS mechanisms

OPERATING SYSTEMS

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MODULE I INTRODUCTION TO OPERATING SYSTEMS

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SUGGESTED ACTIVITIES:
PRACTICAL:
I - Shell programming assignments

EL
1. Shell programming
2. Read the history of Unix/Linux/Windows
3. Know the operating system in your phone/laptop
4. System boot up process of Windows / Linux

SUGGESTED EVALUATION METHODS:
- Quiz on understanding of Linux and shell programming

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SUGGESTED ACTIVITIES:
Practical:
1. Use of ps, ps lx, ps tree, ps –aux commands
2. Use of top command to display resource usage statistics of processes
3. Use of the fork, clone, exec, wait, exit system calls
4. Inter-process communication using pipes, shared memory

EL: Learn to write a makefile, to use gdb and to use grep

SUGGESTED EVALUATION METHODS:
- Implementation evaluation
- EL assignment to be appropriately evaluated

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<tr>
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Threads – Overview – Multithreading models – Pthreads

SUGGESTED ACTIVITIES:
Practical:
- Implement multi-threading using the Pthread library

EL: Java threads

SUGGESTED EVALUATION METHODS:
- Evaluation of the implementation of multi-threading

<table>
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<th>MODULE IV</th>
<th>CPU SCHEDULING</th>
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Basic Concepts of CPU Scheduling – Scheduling Criteria – Scheduling Algorithms

SUGGESTED ACTIVITIES:
Practical:
- Simulation of CPU scheduling algorithms

EL:
- Assignment problems on CPU scheduling algorithms

SUGGESTED EVALUATION METHODS:
- Assignments to be appropriately evaluated.
### MODULE V  PROCESS SYNCHRONIZATION

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**SUGGESTED ACTIVITIES:**

**Practical:**
1. Solutions to Synchronization problems using semaphores
2. Introduction to xv6: download and build
3. Run the kernel inside QEMU gdb

**EL:**
Reading details about xv6 operating system

**SUGGESTED EVALUATION METHODS:**
- Implementation evaluation
- Quiz on the understanding of the different concepts in this module

### MODULE VI  STORAGE MANAGEMENT

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**SUGGESTED ACTIVITIES:**

**Practical:**
1. Use of system calls like creat, open, read, write, close, dup, readdir and scandir
2. Read the file xv6/fs.h to understand how a directory entry, a superblock and the contents of an inode are implemented in xv6
3. Read the file xv6/fs.c to understand how a new entry is added to a directory and explain the functions involved.

**EL:**
Read about the contents of a superblock, a directory entry, and an inode in UNIX-like operating systems

**SUGGESTED EVALUATION METHODS:**
- Quizzes

### MODULE VII  MEMORY MANAGEMENT

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Contiguous Memory Allocation – Paging – Structure of the Page Table – Segmentation – Paging with segmentation

**SUGGESTED ACTIVITIES :**

**Practical:**
1. Read and understand appropriate files in xv6 related to process scheduling and memory management

**EL:**
Assignment problems on memory management

**SUGGESTED EVALUATION METHODS:**
- Quiz on xv6 study files

### MODULE VIII  VIRTUAL MEMORY MANAGEMENT

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SUGGESTED ACTIVITIES

Practical:
- Implementation of at least one of the page replacement policies
- Implementation of a new system call in xv6

EL:
- Assignments on page replacement algorithms

SUGGESTED EVALUATION METHODS

- Evaluation of the coding assignments
- Quiz on the different parts of the module

OUTCOMES:

Upon completion of the course, the students will be able to:
- Articulate the main concepts, key ideas, strengths and limitations of Operating Systems
- Analyze the structure and basic architectural components of OS
- Elaborate and design various scheduling algorithms
- Discuss various memory management schemes and design them
- Point out the various aspects of storage management

TEXT BOOK:


REFERENCES:

4. Russ Cox, Frans Kaashoek and Robert Morris. "xv6: A Simple, Unix-like Teaching Operating System", Revision 8. (Free and can be downloaded)

SOURCE CODE

The xv6 source code is available via: git clone git://pdos.csail.mit.edu/xv6/xv6.git

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CS 6109

COMPILER DESIGN

OBJECTIVES:

- To know about the various transformations in the different phases of the compiler, error handling and means of implementing the phases
- To learn about the techniques for tokenization and parsing
- To understand the ways of converting a source language to intermediate representation
- To have an idea about the different ways of generating assembly code
- To have a brief understanding about the various code optimization techniques

COMPILER DESIGN

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Phases of the compiler – compiler construction tools – role of assemblers, macroprocessors, loaders, linkers.

SUGGESTED ACTIVITIES:

- EL – Constructs of programming languages - C, C++, Java
- LEX tool tutorial

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE II:

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SUGGESTED ACTIVITIES:

- EL – LEX tool for tokenization
- Problems based on conversion from NFA to DFA, Epsilon NFA to DFA
- Practical – Programs using LEX for tokenization

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE III:

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**SUGGESTED ACTIVITIES:**
- Flipped Classroom – LEX programs
- Problems based on obtaining automata for error routines.
- EL – Implementation of error recovery procedures using LEX/FLEX tool

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

**MODULE IV:**

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Context-Free Grammar (CFG) – Derivation Trees – Ambiguity in Grammars and Languages – Need and Role of the parser

**SUGGESTED ACTIVITIES:**
- EL - CFG for C language constructs
- Problems to check for ambiguity

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE V:**

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Recursive Descent Parsers – LL(1) Parsers – Shift Reduce Parser – LR(0) items - Simple LR parser

**SUGGESTED ACTIVITIES:**
- EL – Push down automata for Parsing, YACC tutorial.
- Problems based on simplification of CFG

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VI:**

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LALR Parser – CALR Parser – Parser Generators – Design of a parser generator

**SUGGESTED ACTIVITIES:**
- EL – YACC tutorial for parsing particular language syntaxes
- Practical – programs using YACC for parsing

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

**MODULE VII:**

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Syntax directed Definitions – Inherited and Synthesized Attributes - Syntax Directed Translation - Construction of Syntax Tree-Type Systems-Specification of a simple type checker
**SUGGESTED ACTIVITIES:**
- EL – Type checking semantic rules for a programming language like C.
- Programs for validating C-lite constructs using YACC

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VIII:**

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Three address code – Types of Three address code – Quadruples, Triples, Three-address code for Declarations, Arrays, Loops, Backpatching

**SUGGESTED ACTIVITIES:**
- Flipped classroom – semantic rules for three-address code a programming language like C.
- Practical – implementation of three-address code generation for a programming language like C.
- EL – Three-address code for Switch-case statements
- Assignment on generating three-address code for arrays, looping constructs with and without backpatching

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

**MODULE IX:**

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Run Time Environment: Source Language Issues - Symbol Tables - Storage Organization-Stack Allocation - Access to nonlocal data on stack – Heap management - Parameter Passing

**SUGGESTED ACTIVITIES:**
- Flipped classroom – suggested parameter passing techniques for a programming language like C.
- Practical – Symbol table implementation

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Practical demo / evaluation

**MODULE X:**

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Basic blocks – Next use – Register allocation – DAG construction – Loops

**SUGGESTED ACTIVITIES:**
- Combination of in class & Flipped
- EL – Basic block, next-use applications,
- EL – alternate register allocation techniques
- Practical – Implementation of Register allocation using Graph colouring

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

**MODULE XI:**

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SUGGESTED ACTIVITIES:
- Combination of in class & Flipped
- EL – Template based code generation
  - Practical – simple code generator for a programming language like C.

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE XII:

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SUGGESTED ACTIVITIES:
- Combination of in class & Flipped
- Practical – Combining and integrating all the implemented features for a programming language like C

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

TEXT BOOK:

REFERENCES:

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

- Comprehensively identify the issues in every phase of the compiler
- Analyse the design issues in the different phases of the compiler and design the phases by integrating appropriate tools
- Identify the apt code generation strategy that needs to be adopted for any given source language
- Analyse and understand the various code optimizations that are necessary for any given intermediate code or assembly level code for sequential algorithms
- Apply and design code optimization techniques for any input code with error recovery
- Design a compiler by incorporating the various phases of the compiler for any new source language

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**CS6110 OBJECT ORIENTED ANALYSIS AND DESIGN**

Prerequisites for the course: None

**OBJECTIVES:**
- To capture the requirements specifications of an intended software system
- To design software with static and dynamic UML diagrams
- To map the design properly to code
- To improve the software design with design patterns
- To test the software against its requirements specifications

**OBJECT ORIENTED ANALYSIS AND DESIGN**

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**MODULE I:**
- Introduction to OOAD with OO Basics - Unified Process – UML diagrams

**SUGGESTED ACTIVITIES:**
- EL - Identifying a suitable case study to work on for a complete end-end implementation
- EL – Document the Software Requirement Specifications(SRS) for the identified case study
- Practical – Getting familiar with the case tool

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE II:**
- Use Cases –Case study – the Next Gen Point of Sale(POS) system, Inception Use case Modelling

78
### SUGGESTED ACTIVITIES:
- **EL** – Identify use cases for the chosen case study and develop the Use Case model.
- **Practical** – Presenting the SRS for the chosen case study and obtaining approval

### SUGGESTED EVALUATION METHODS:
- Presentations
- Quizzes

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<tbody>
<tr>
<td>Use case modeling - Relating Use cases – include, extend and generalization - Class Diagram—Elaboration – Domain Model – Finding conceptual classes and description classes – Associations – Attributes</td>
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### SUGGESTED ACTIVITIES:
1. **EL** - Identify the conceptual classes to develop a Domain Model and Class Diagram.
2. **Practical** – Presenting the use case model (for the chosen case study) along with use case diagrams.

### SUGGESTED EVALUATION METHODS:
- Presentations
- Quizzes

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<tr>
<td>Domain Modeling using class diagrams - Domain model refinement – Finding conceptual class Hierarchies – Aggregation and Composition</td>
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### SUGGESTED ACTIVITIES:
- **EL** – Expand the domain model by identifying the hierarchies, association, aggregation and composition
- **Practical** – Present the refined use case model and the basic domain model

### SUGGESTED EVALUATION METHODS:
- Presentations
- Quizzes

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<tr>
<td>Dynamic Diagrams - UML interaction diagrams - System sequence diagram – Collaboration diagram - Communication diagram</td>
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### SUGGESTED ACTIVITIES:
- **EL** – Develop sequence diagrams for the scenarios identified in the use case model
- **Practical** – Presenting the complete domain model (after refinement) and class diagrams for the chosen case study

### SUGGESTED EVALUATION METHODS:
- Presentations
- Quizzes

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<tr>
<td>State machine diagram and Modelling – State Diagram - Activity diagram</td>
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### SUGGESTED ACTIVITIES:
- **EL** - Develop state and activity diagrams for the chosen case study
• Practical – Presenting the dynamic model with sequence diagrams

**SUGGESTED EVALUATION METHODS:**
- Presentations
- Quizzes

**MODULE VII:**

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Implementation Diagram - UML package diagram - Component and Deployment Diagrams

**SUGGESTED ACTIVITIES:**
- EL – Finalize the environment and initiate implementation
- Practical – Presenting the complete dynamic model with state and activity diagrams and refined sequence diagrams

**SUGGESTED EVALUATION METHODS:**
- Presentations
- Quizzes

**MODULE VIII:**

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**SUGGESTED ACTIVITIES:**
- EL – Continue with the implementation
- Practical – Demonstrate partial implementation

**SUGGESTED EVALUATION METHODS:**
- Practical demonstration
- Quizzes

**MODULE IX:**

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Applying Gang of Four design patterns – Mapping design to code

**SUGGESTED ACTIVITIES:**
- EL – Identifying suitable design patterns to improve the design and documenting the rationale behind their selection. Proceed with the refined implementation by applying them,
- Practical – Demonstrate complete implementation without the design patterns

**SUGGESTED EVALUATION METHODS:**
- Practical demonstration
- Quizzes

**MODULE X:**

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Object Oriented Methodologies – Software Quality Assurance – Impact of object orientation on Testing – Develop Test Cases and Test Plans

**SUGGESTED ACTIVITIES:**
- EL – Developing a Test plan with all test cases
- Practical – Present the modified design with appropriate design patterns. Demonstrate the implementation after incorporating the implementation of suitable design patterns

**SUGGESTED EVALUATION METHODS:**
- Presentations
- Quizzes
Revisiting and consolidating all salient points and key insights based on the team projects

Suggested Activities:
- Practical – Demonstrating the test plan and the various test cases

Suggested Evaluation:
- Presentations

OUTCOMES:
Upon completion of the course, the students will be able to:
- Identify and map basic software system requirements in UML
- Express software design with UML diagrams
- Design and implement software systems using OO methodology
- Improve software design using design patterns
- Test the software system developed against the intended requirements

TEXT BOOK:

REFERENCES:
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, “Design Patterns: Elements of Reusable Object-Oriented Software”, Pearson, 2015.

EVALUATION METHOD TO BE USED:

<table>
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CS 6111

OBJECTIVES
- To understand the division of network functionality into layers
- To familiarize the functions and protocols of each layer of the TCP/IP protocol suite
- To visualize the end-to-end flow of information
- To understand the components required to build different types of networks
- To learn concepts related to network addressing and routing

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<th>MODULE I:</th>
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<tr>
<td>Building a network - Network edge and core – Layered Architecture – ISO/OSI Model – Internet Architecture (TCP/IP) - Performance Metrics – Introduction to Sockets.</td>
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**SUGGESTED ACTIVITIES:**
- Performance Metrics – In class
- EL - Socket Programming
- Practical – Socket Programming

**SUGGESTED EVALUATION METHODS:**
- Problems on Performance Metrics

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<tbody>
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<td>Application Layer protocols – HTTP- FTP – Email – DNS</td>
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**SUGGESTED ACTIVITIES:**
- EL - HTTP/DNS format using Wireshark
- Practical – Implementation of HTTP, Web Caching, FTP using socket programming

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quiz on Wireshark

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<tr>
<td>Transport Layer: End to End Protocols – Connectionless Transport: User Datagram Protocol – UDP Applications.</td>
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**SUGGESTED ACTIVITIES:**
- EL - Wireshark for UDP, TCP packet formats
- Practical – Socket Programming on UDP, Implementation of DNS using UDP

**SUGGESTED EVALUATION METHODS:**
- Quiz on UDP applications

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**SUGGESTED ACTIVITIES:**
- EL – Transport layer for Real Time Applications
- Analysis in Class – Flow Control
- Practical – Flow Control

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quiz on Real time transport protocols

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**SUGGESTED ACTIVITIES:**
- EL- IPV6
- Practical – Basic network construction using simulator
### SUGGESTED EVALUATION METHODS:
- Assignment Problems
- Quizzes

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Subnetting – Variable Length Subnet Mask (VLSM) - Classless Inter Domain Routing (CIDR) - DHCP - ICMP

### SUGGESTED ACTIVITIES:
- In class – Problems on Subnetting,
- EL – Problems on CIDR

### SUGGESTED EVALUATION METHODS:
- Assignment Problems

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### SUGGESTED ACTIVITIES:
- In Class – Problems in Distance Vector Routing, Link State Routing
- EL - RIP, OSPF
- Practical – Performance analysis of different network topologies and routing protocols using suitable simulator

### SUGGESTED EVALUATION METHODS:
- Assignment problems

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BGP- Introduction to Quality of Services (QoS). Data Link Layer: Link Layer – Framing – Addressing – Error Detection/Correction

### SUGGESTED ACTIVITIES:
- In class: Error Detection and Correction
- EL – Problems on QoS

### SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Medium Access Control – Address Resolution Protocol (ARP) – Network Address Translation (NAT) - Ethernet Basics - CSMA/CD - Virtual LAN – Wireless LAN (802.11) – WAN Technologies

### SUGGESTED ACTIVITIES:
- EL – RARP

### SUGGESTED EVALUATION METHODS:
- Quizzes

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SUGGESTED ACTIVITIES:
- In class – Encoding techniques problems
- EL – Recent developments in transmission media
- Practical – Topology setup using Hubs, Switches and Bridges using simulator.

SUGGESTED EVALUATION METHODS:
- Quizzes

OUTCOMES:
Upon completion of the course, the students will be able to:
- Highlight the significance of the functions of each layer in the network
- Identify the devices and protocols to design a network and implement it
- Build network applications using the right set of protocols and estimate their performance
- Trace packet flows and interpret packet formats
- Apply addressing principles such as subnetting and VLSM for efficient routing
- Explain media access and communication techniques

TEXT BOOKS:

REFERENCES:

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CS6611 CREATIVE AND INNOVATIVE PROJECT

OBJECTIVES:
- To identify the problem based on societal needs
- To interview people on societal problems that require computerization
- To suggest creative solutions to societal problems
- To explore possible alternative solutions
- To estimate risk and develop a prototype
The aim of this course is to encourage the students to identify projects that help in exploring variables that promote creativity and innovation. Each student is expected to choose a real life or socially relevant problem. At the end of the project, students should be familiar with the state of art in their respective fields. They would be able to apply the concepts learnt to relevant research problems or practical applications. This course is to motivate them to learn concepts, models, frameworks, and tools that engineering graduates' need in a world where creativity and innovation is fast becoming a pre-condition for competitive advantage.

OUTCOMES:
Upon completion of this course, the students will be able to
- Convert user requirements to a software architecture diagram
- Identify and specify the pre-processing necessary to solve a problem
- Suggest optimum solutions by comparing the different solutions from an algorithmic perspective
- Discover the research implications in any societal problem
- Design and use performance metrics to evaluate a designed system
- Perform SWOT and PESTEL Analysis

1. Internals
   a. First Review
      i. Block Diagram of the proposed solution for a societal/creative problem
      ii. New Contribution in terms of modifications to existing algorithm or suggestion of new ones
      iii. Detailed Design of each module
      iv. Evaluation Metrics
      v. Test Cases
   b. Second Review
      i. Implementation - Justifying pros and Cons
      ii. Coding - highlighting what has been reused and what is being written
   c. Third Review
      i. Test Runs
      ii. Performance Evaluation based on Metrics
      iii. Project Documentation

2. Externals
   - Presentation, Viva-Voce, Report submission.

OUTCOMES:
Upon completion of the course, the students will be able to
- Assess the needs of the society
- Describe the background of the problem
- Formulate a problem
- Perform SWOT and PESTEL Analysis
- Frame a policy
- Predict business opportunity
- Design the prototype
- Gain knowledge on system implications.
MA6201
LINEAR ALGEBRA

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OBJECTIVES:
- To learn to analyze a linear system of equations
- To study the properties of a linear transformation
- To understand the process of orthogonalization
- To learn to solve linear equations using different methods
- To understand the applications of linear algebra in engineering

MODULE I
Vector spaces – Subspaces – Linear combinations and linear system of equations

SUGGESTED ACTIVITIES :
- Problem solving sessions

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE II
Linear independence and Linear dependence – Basis and Dimension

SUGGESTED ACTIVITIES :
- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE III
Linear Transformation – Null space, Range space - Dimension theorem - Matrix representations of Linear Transformations

SUGGESTED ACTIVITIES :
- Problem solving sessions

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV
Eigenvalues and Eigenvectors of a linear transformation – Diagonalization of linear transformations – Application of diagonalization in a linear system of differential equations

SUGGESTED ACTIVITIES :
- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
**MODULE V**

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Inner Product Spaces – Norms - Orthogonal vectors – Gram Schmidt orthogonalization process - Least Square Approximations

**SUGGESTED ACTIVITIES:**
- Problem solving sessions

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VI**

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**SUGGESTED ACTIVITIES:**
- Problem solving sessions
- Applications in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VII**

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Iterative methods: Gauss-Jacobi and Gauss-Seidel – SOR Method

**SUGGESTED ACTIVITIES:**
- Problem solving sessions
- Applications in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VIII**

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Eigenvalue Problems: Power method – Inverse Power method - Jacobi’s rotation method

**SUGGESTED ACTIVITIES:**
- Problem solving sessions
- Applications in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE IX**

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QR decomposition - Singular Value Decomposition method

**SUGGESTED ACTIVITIES:**
- Problem solving sessions
- Applications in real life problems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
OUTCOMES:
Upon completion of the course, the students will be able to
- Perform linear transformations and write down the matrix representing a linear transformation
- Find the Gram-Schmidt orthogonalization of a matrix
- Determine the rank, determinant, eigenvalues and eigenvectors, diagonalization, and different factorizations of a matrix
- Solve a linear system of equations using direct and iterative methods
- Solve Eigen value problems
- Formulate linear equations for real life problems and solve them

TEXT BOOKS:

REFERENCES:

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Prerequisites for the course: Discrete Mathematics

OBJECTIVES:
- To understand the fundamentals of graph theory
- To study the proofs related to various concepts in graphs
- To study about the different types of graphs and their properties
- To learn about the distinguishing features of various graph algorithms
- To study the applications of graphs in solving engineering problems

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Introduction - Graph Terminologies - Types of Graphs - Isomorphism - Isomorphic Graphs - Operations on graphs - Degree sequences - Euler graph - Hamiltonian Graph - Related theorems.

SUGGESTED ACTIVITIES:
- EL: Graphs and tournaments, Graphs in real world applications

SUGGESTED EVALUATION METHODS:
- Assignment on graphs in real world applications

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SUGGESTED ACTIVITIES:
- Graph Isometry Problems

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Quizzes

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Trees - Properties - Distance and Centres - Types - Rooted and Binary Tree - Labeled Tree - Unlabeled Tree

SUGGESTED ACTIVITIES:
- EL: Binary trees and signed trees

SUGGESTED EVALUATION METHODS:
- Tutorial problems and assignment problems on generating trees with specified properties

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Spanning Tree - Fundamental Circuits - Cut Sets - Properties - Connectivity - Separability – Network Flows - 1-isomorphism, 2-isomorphism - Related Theorems

SUGGESTED ACTIVITIES:
- Concept maps to relate spanning trees with other topics

SUGGESTED EVALUATION METHODS:
• Tutorial problems on proof techniques
• Assignment problems on graph connectivity

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Planar Graph - Representation - Detection of planarity - Dual Graph - Related Theorems.

SUGGESTED ACTIVITIES:
• Identification of planar and non-planar graphs

SUGGESTED EVALUATION METHODS:
• Tutorial problems on proving related theorems

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Digraph - Properties - Euler Digraph – Tournament graph - Applications.

SUGGESTED ACTIVITIES:
• EL: Application of Digraph

SUGGESTED EVALUATION METHODS:
• Assignment problems

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SUGGESTED ACTIVITIES:
• Graph representation for different types of graphs

SUGGESTED EVALUATION METHODS:
• Tutorial problems on comparative analysis on representation methods
• Assignment problems

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Graph Coloring - Chromatic Polynomial - Chromatic Partitioning - Matching - Covering - Related Theorems

SUGGESTED ACTIVITIES:
• EL: Edge coloring and example problems

SUGGESTED EVALUATION METHODS:
• Tutorial problems to find chromatic number of special graphs
• Assignment problems on applications using matching and covering

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Graph Algorithms- Connectedness and Components- Spanning Tree - Fundamental Circuits – Cut Vertices.

SUGGESTED ACTIVITIES:
• Programming on related algorithms

SUGGESTED EVALUATION METHODS:
• Demo on the programs for small applications

Attested
SUGGESTED ACTIVITIES:
- Project based learning to apply suitable concepts for a small application

SUGGESTED EVALUATION METHODS:
- Mini Project demo and evaluation

OUTCOMES:
Upon completion of the course, the students will be able to:
- Point out the basic concepts of graphs, and different types of graphs
- Discuss the properties, theorems and be able to prove theorems
- Apply suitable graph models and algorithms for solving engineering problems
- Analyse various representations of graphs
- Analyse graph algorithms and discuss their suitability for applications

TEXT BOOKS:

REFERENCES:

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EC6201 SIGNALS AND SYSTEMS

OBJECTIVES:
- To understand the types of signals and systems
- To gain knowledge about understanding continuous time and discrete time signals.
- To learn time domain and frequency domain analysis of signals
- To learn the transformations from time domain to frequency domain
To gain knowledge about the various functionalities available in signal processing software to support signal processing applications

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<td>Classification of Signals - Useful Signal models – periodic and a periodic signals, random signals, Energy &amp; Power signals -Systems – Classification of systems</td>
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**SUGGESTED ACTIVITIES:**
- In Class activity – expressing signals as a function of step, ramp.
- Practical – Plotting of Continuous signals and operations on them using either Open CV, MATLAB, OCTAVE
- EL – Study of any one Open CV, MATLAB, OCTAVE

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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<td>Time Domain analysis of continuous-time systems – unit impulse response – Convolution Integral – System response</td>
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**SUGGESTED ACTIVITIES:**
- EL – Visualizing signals of practical day to day activities like traffic light, count of vehicles, temperature of the day, stock market changes
- Practical - Implementation of continuous signals and understanding

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

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<th>MODULE III</th>
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<tr>
<td>Fourier Series – Periodic representation by trigonometric Fourier series – Role of amplitude and phase spectra - LTI continuous system response to periodic inputs – Signals as vectors</td>
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**SUGGESTED ACTIVITIES:**
- EL – Flipped Class-room – Signal representation by orthogonal signal set
- Practical – Fourier series application using Open CV, MATLAB or OCTAVE

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

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<td>Fourier Transform – Aperiodic representation by Fourier integral – Properties of Fourier transform – Fourier transform in the analysis of Continuous time systems</td>
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**SUGGESTED ACTIVITIES:**
- Flipped Class room
- EL – Application of Fourier transform
- Practical –Properties of Fourier transform implementation using Open CV, MATLAB, or OCTAVE

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

**MODULE V**

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Classification of Discrete time systems – Sampling theorem – signal reconstruction – Discrete-time signal models

**SUGGESTED ACTIVITIES :**
- EL – Signal operations
- Practical - Open CV, MATLAB, or OCTAVE – implementation and visualization of discrete time systems

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

**MODULE VI**

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Impulse response – Convolution sum – Discrete time systems response – Differential equation – Block diagram representation of Discrete time systems

**SUGGESTED ACTIVITIES :**
- EL – Impulse response for special cases, Correlation
- Practical –Convolution Implementation using MATLAB, OCTAVE or Open CV

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

**MODULE VII**

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**SUGGESTED ACTIVITIES :**
- Practical –Implementation of Z-transform using Open CV, MATLAB, or OCTAVE
- EL – Bilateral Z-transform, Inverse Z-transform using alternate methods

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

**MODULE VIII**

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Discrete Time Fourier transform – Properties – Inverse Discrete Time Fourier Transform
SUGGESTED ACTIVITIES:
- EL – DTFS, relationship between DTFT and Z-transform
- Practical – Implementation DFT, properties using MATLAB, OCTAVE or Open CV

MODULE IX

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Discrete Fourier Transform – Properties – Circular Convolution – Inverse Discrete Fourier transform

SUGGESTED ACTIVITIES:
- EL – DTFS, relationship between DTFT and Z-transform
- Practical – Implementation DFT, properties using MATLAB, OCTAVE or Open CV

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE X

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SUGGESTED ACTIVITIES:
- EL – Radix – n implementation of Fast Fourier Transform
- Practical – Analyzing the FFT of signals and their interpretation

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Practical exercises demo

MODULE XI

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Fast Fourier transform – Decimation in frequency – Radix-2 algorithm - Inverse DFT using one FFT technique

SUGGESTED ACTIVITIES:
- EL – Derivation of Radix-n FFT for DIF algorithms

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Quizzes

OUTCOMES:
Upon completion of the course, the students will be able to:
- Analyze and classify any given signal and system
- Propose appropriate time domain and frequency domain analysis for a signal to satisfy an application
- Suggest appropriate frequency transformation to convert an analog signal to a digital signal
- Convert any input data to a signal and analyse it mathematically
- Code and represent a signal and analyse using a signal processing software
TEXT BOOKS:

REFERENCES:

EVALUATION PATTERN:

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CS6202 THEORY OF COMPUTATION

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OBJECTIVES:
- To understand the Chomsky language hierarchy
- To construct automata for any given pattern and find its equivalent regular expressions
- To design CFG for any given language and prove its equivalence
- To understand the need for Turing machines and their capability
- To understand undecidable problems

MODULE I:

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Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Finite Automata with Epsilon Transitions – NFA to DFA conversion – Epsilon NFA to DFA conversion
**Suggested Activities:**
- Defining automata for different types of patterns
- EL – Epsilon NFA to DFA direct conversion

**Suggested Evaluation Methods:**
- Tutorial problems
- Assignment problems
- Quizzes

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Regular Expression – FA and Regular Expressions – Pumping Lemma for Regular Languages

**Suggested Activities:**
- Proofs in class
- EL – Regular expression for practical patterns

**Suggested Evaluation Methods:**
- Tutorial problems
- Assignment problems
- Quizzes

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Properties of Regular languages - Equivalence and Minimization of Automata

**Suggested Activities:**
- Flipped Class room – Moore and Mealy machines
- Problems based on properties – in-class and EL

**Suggested Evaluation Methods:**
- Tutorial problems
- Assignment problems
- Quizzes

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Context-Free Grammar (CFG) – Derivation Trees – Ambiguity in Grammars and Languages – Equivalence of Parse Trees and Derivation

**Suggested Activities:**
- EL - CFG for practical programming constructs
- EL – Alternate theorems and proofs

**Suggested Evaluation Methods:**
- Tutorial problems
- Assignment problems
- Quizzes

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Simplification of Context-free Grammar – Chomsky Normal Form – Greibach Normal Form

**Suggested Activities:**
- EL – Problems based on context-free grammar
- Proofs of all the grammar equivalence – in-class
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**SUGGESTED ACTIVITIES:**
- Proofs – in-class
- EL – String acceptance using the converted PDA from CFG and CFG from PDA
- EL - Problems based on properties of CFL

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VII:**

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Turing Machines – Language of a Turing Machine – Turing Machine as a Computing Device

**SUGGESTED ACTIVITIES:**
- EL – problems on Turing machines as language acceptors, computing device
- In-class and EL – Turing machines as computing functions in both unary and binary representation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VIII:**

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Techniques for TM – Modifications of Turing Machines – Two-way Infinite Tape, Equivalence of One Way Infinite Tape and Two-way Infinite Tape Turing Machines – Multi Tape Turing Machines

**SUGGESTED ACTIVITIES:**
- Flipped Class room – Non-deterministic Turing machines, multi-dimensional Turing machine

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE IX:**

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Chomsky hierarchy - A Language that is not Recursively Enumerable (RE) – An Undecidable Problem that is RE – Undecidable Problems about Turing Machine – Universal language – $L_r$, $L_{nr}$, $L_e$, $L_{ne}$, - Rice Theorem for Recursive and Recursively Enumerable Languages

**SUGGESTED ACTIVITIES:**
- EL – Halting problem and other undecidable problems and their proofs

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
Undecidable nature of Post Correspondence Problem and Modified Post Correspondence problem

SUGGESTED ACTIVITIES:
- EL – Problems based on PCP, MPCP and conversions

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

OUTCOMES:
Upon completion of the course, the students will be able to:
- Classify languages based on Chomsky hierarchy
- Identify the class of language and design automata or Type x grammar
- Prove equivalence of the different language representations within a class of the Chomsky hierarchy
- Identify the undecidable problems and their class of languages
- Apply and prove a given language is decidable or undecidable

TEXT BOOK:

REFERENCES:

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98
OBJECTIVES:

- To understand the need for machine learning for various types of problem solving
- To know the mathematics involved in various machine learning algorithms
- To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning
- To learn about probabilistic models in machine learning
- To have a glimpse of the latest developments in machine learning

### CS 6301 MACHINE LEARNING

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#### MODULE I:


**SUGGESTED ACTIVITIES:**

- EL – Fundamentals of Predictive Analytics, Study of tools for data mining like WEKA, KNIME, Rapidminer, etc
- Practical – Study of tools like WEKA, KNIME and the UCI repository datasets

**SUGGESTED EVALUATION METHODS:**

- Tutorial problems
- Assignment problems
- Quizzes

#### MODULE II:

- Neural Networks – Perceptron – Linear Separability – Linear Regression

**SUGGESTED ACTIVITIES:**

- In-class activity – practical problems and the need for machine learning algorithms
- EL – Working with tools and standard data sets
- Practical - Implementation of the Candidate Elimination Algorithm

**SUGGESTED EVALUATION METHODS:**

- Tutorial problems
- Assignment problems
- Practical demonstrations
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<tr>
<td>Suggested Activities:</td>
<td>Flipped classroom and activity&lt;br&gt;EL – Applications of MLP&lt;br&gt;Practical – Implementation of the Neural Network perceptron algorithm and enhancing it to other variations&lt;br&gt;Proposal for Mini Project</td>
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<td>Suggested Evaluation Methods:</td>
<td>Tutorial problems&lt;br&gt;Assignment problems&lt;br&gt;Approval of Mini project based on the reference papers, abstract and design</td>
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<tr>
<td>Suggested Activities:</td>
<td>Flipped Classroom&lt;br&gt;EL – Applications of RBF Networks&lt;br&gt;Practical – Implementation of Multi-layer Perceptron</td>
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<td>Suggested Evaluation Methods:</td>
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<tr>
<td>Suggested Activities:</td>
<td>EL – Probabilistic PCA and Factor analysis concepts&lt;br&gt;Practical – Implementation of Independent Component Analysis (ICA) algorithm&lt;br&gt;Practical – Mini-project design completion</td>
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<td>Suggested Evaluation Methods:</td>
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<tr>
<td>Suggested Activities:</td>
<td>EL – Application of SVM, Nearest Neighbor concepts and other regression models on various datasets&lt;br&gt;Practical – Implementation of Support Vector Machines with various kernel models, Nearest Neighbor models</td>
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Radial Basis Function Network - Concepts – Training - Interpolation and Basis Functions – Solutions using RBF

Dimensionality Reduction – Linear Discriminant Analysis - Principal Component Analysis - Factor Analysis - Independent Component Analysis - Locally Linear Embedding - Isomap

- Continuation of mini project, minimum 40% implementation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Practical demonstration of algorithms and mini project

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<tr>
<td>Evolutionary Learning-The Genetic Algorithm-Genetic Operators-Using Genetic Algorithms-Genetic Programming - Applications</td>
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**SUGGESTED ACTIVITIES :**
- Flipped Classroom for applications
- EL – Applications of Evolutionary algorithms
- Practical – Implementation of GA, Continuation of mini-project

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Practical demonstrations

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<td>Reinforcement Learning – Markov Decision Processes - Values-The difference between SARSA and Q-Learning</td>
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**SUGGESTED ACTIVITIES :**
- Flipped Classroom for applications
- EL – Applications of Evolutionary algorithms
- Practical – Continuation of mini-project

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Practical demonstrations

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<tr>
<td>Learning with Trees-Using Decision trees-Constructing Decision Trees-Classification and regression trees-Classification example-Decision by committee: Ensemble Learning-Boosting-Bagging-Random Forests-Different ways to combine classifiers</td>
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**SUGGESTED ACTIVITIES :**
- EL – Applications of Decision tree, CART
- Practical –Implementation of Decision Trees, Bagging, Boosting and EM algorithms
  - Continuation of mini-project

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Practical demonstrations, Mini project 80% completion

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</table>
Unsupervised Learning - The K-Means Algorithm - Vector Quantization - The self-organizing feature map

**SUGGESTED ACTIVITIES:**
- Combinations of in Class & Flipped class rooms
- EL – K-Means algorithm applications
- Practical - Implementations of K-Means algorithm

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Practical demonstrations

**MODULE XI**

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<tr>
<td>Deep learning introduction – CNN – RNN</td>
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**SUGGESTED ACTIVITIES:**
- EL – Survey of deep learning network models
- Practical – Mini-project demonstration

**SUGGESTED EVALUATION METHODS:**
- Mini project final evaluation

**OUTCOMES:**
Upon completion of the course, the students will be able to
- Differentiate between supervised, unsupervised, semi-supervised machine learning approaches
- Choose and implement classification or regression algorithms for an application using an open source tool
- Implement probabilistic, discriminative and generative algorithms for an application and analyze the results
- Use a tool to implement typical clustering algorithms for different types of applications
- Create potential solutions for real time applications using machine learning techniques

**TEXT BOOKS**

**REFERENCES:**

**EVALUATION METHOD:**

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<tr>
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</table>
Prerequisites for the course: Data Structures and Algorithms

OBJECTIVES:

- To introduce the major programming paradigms with the principles and the techniques involved in the design and implementation of modern programming languages
- To introduce the framework for specifying and reasoning about programming languages
- To analyse a given program from the perspective of good programming practices
- To compare and contrast the range of programming paradigms
- To evaluate programming language features critically with respect to the way they support good software engineering practices
- To discuss the appropriateness of the use of a given programming paradigm within a given environment

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<th>PROGRAMMING PARADIGMS</th>
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OBJECTIVES:

MODULE I:

The art of Language design – Programming language spectrum - Compilation and Interpretation– Evaluation of Programming languages

SUGGESTED ACTIVITIES:
- Activity based learning - brain storming quizzes and puzzles of programming languages

SUGGESTED EVALUATION METHODS:
- Quizzes

MODULE II:

Languages – Syntax and Semantics of language C-lite - Names – Types – Type Systems - Binding – Scope – Static – Dynamic – Abstract Data types

SUGGESTED ACTIVITIES:
- Using peer learning- Interaction and group discussion about data types
### Suggested Evaluation Methods:
- Quizzes
- Assignment problems

### Module III:
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Expression – Assignment - Control flow – Input/output – exception handling - exception hierarchy-throwing and catching exception

### Suggested Activities:
- Problem based learning for solving problems using various exception handling techniques in the module.

### Module IV:
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Introduction to semantics - state transformation – partial functions – semantics with dynamic typing – Formal treatment of semantics

### Suggested Activities:
- Outcome based learning- various assessment tests for the above four modules.

### Module V:
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Functions - Call and Return – Parameter passing – function declaration – semantics of call and return

### Suggested Activities:
- Activity based learning - quizzes and puzzles related to using functions

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Formal treatment of types and semantics – memory management – dynamic arrays – garbage collection

### Suggested Activities:
- Problem based learning - Solving problems using dynamic arrays

### Module VII:
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Programming techniques-Imperative programming – C – ADA – Perl

### Suggested Activities:
Based on project learning, develop a mini project based on C or Perl

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

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Object Oriented Programming - grouping of data and operations - constructs for program structuring - information hiding - program design with modules - Object Oriented Programming – Small Talk – Java – Python

**SUGGESTED ACTIVITIES:**
- Case study to understand OOPs concepts of Java and Python

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

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Functional Programming – Introduction to Scheme and Haskell - Expressions - types and functions

**SUGGESTED ACTIVITIES:**
- Problem solving paradigms in Functional programming

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

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**SUGGESTED ACTIVITIES:**
- Project based learning to apply suitable concepts for a small application.

**SUGGESTED EVALUATION METHODS:**
- Mini Project evaluation

**TEXT BOOKS:**

**REFERENCES**

**OUTCOMES:**
Upon completion of the course, the students will be able to:
• Write programs related to syntax and semantics
• Compare programs between C, Perl and Small Talk
• Write programs using scripting languages
• Demonstrate event-driven and concurrent programming using Prolog
• Apply Prolog for developing distributed systems

**EVALUATION METHOD:**

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**CS6303 DISTRIBUTED SYSTEMS**

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**Prerequisites for the course:** NONE

**OBJECTIVES:**

- To understand the foundations of distributed systems
- To learn issues related to clock Synchronization and the need for global state in distributed systems
- To learn distributed mutual exclusion and deadlock detection algorithms
- To understand the significance of agreement, fault tolerance and recovery protocols in distributed systems
- To learn the characteristics of peer-to-peer and distributed shared memory systems

**MODULE I  INTRODUCTION**

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**SUGGESTED ACTIVITIES :**

- EL – Fundamentals of Distributed Systems
- Flipped classroom and activity

**SUGGESTED EVALUATION METHODS:**

- Assignment problems
- Quizzes

**MODULE II  A MODEL OF DISTRIBUTED COMPUTATIONS AND LOGICAL TIME**

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A distributed program –A model of distributed executions –Models of communication networks –
Global state – Cuts – Past and future cones of an event – Models of process communications – A framework for a system of logical clocks – Scalar time – Vector time – Physical clock synchronization: NTP.

**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- EL – Basics of Communication Networks

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### MODULE III MESSAGE ORDERING AND GROUP COMMUNICATION

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Message ordering paradigms – Asynchronous execution with synchronous communication – Synchronous program order on an asynchronous system – Group communication – Causal order (CO) - Total order.

**SUGGESTED ACTIVITIES:**
- EL- Basic concepts on Group Communication
- In class Activity on Message Ordering

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### MODULE IV GLOBAL STATE AND SNAPSHOT RECORDING ALGORITHMS

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Introduction – System model and definitions – Snapshot algorithms for FIFO channels.

**SUGGESTED ACTIVITIES:**
- Flipped Class room
- EL - Introduction to Snapshot Algorithm

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### MODULE V DISTRIBUTED MUTUAL EXCLUSION ALGORITHMS

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**SUGGESTED ACTIVITIES:**
- EL – Introduction to Mutual Exclusion
- In class activity on problem solving in Distributed Mutual Exclusion Algorithms

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
## Module VI: Deadlock Detection in Distributed Systems

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### Suggested Activities:
- EL – Introduction to Deadlock Detection.
- Flipped classroom and activity

### Suggested Evaluation Methods:
- Assignment problems
- Quizzes

## Module VII: Checkpointing and Rollback Recovery

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Introduction – Background and definitions – Issues in failure recovery – Checkpoint-based recovery – Log-based rollback recovery – Coordinated checkpointing algorithm – Algorithm for asynchronous checkpointing and recovery.

### Suggested Activities:
- Combinations of in Class & Flipped class rooms
- EL – Applications for Rollback Recovery

### Suggested Evaluation Methods:
- Assignment problems
- Quizzes

## Module VIII: Consensus and Agreement Algorithms

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Problem definition – Overview of results – Agreement in a failure-free system – Agreement in synchronous systems with failures.

### Suggested Activities:
- Flipped classroom
- EL – Basics concepts of Agreement Algorithms

### Suggested Evaluation Methods:
- Assignment problems
- Quizzes

## Module IX: Peer-to-Peer Computing and Overlay Graphs

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Introduction – Data indexing and overlays – Chord – Content addressable networks – Tapestry.

### Suggested Activities:
- Flipped classroom and activity
- EL – Introduction to peer to peer computing

## Module X: Distributed Shared Memory

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Abstraction and advantages – Memory consistency models – Shared memory Mutual Exclusion.
SUGGESTED ACTIVITIES:
- Flipped classroom and activity
- EL – Introduction to Memory Consistency Models

OUTCOMES:
Upon completion of the course, the students will be able to:
- Elucidate the foundations and issues of distributed systems
- Point out the various synchronization issues and global state for distributed systems
- Demonstrate the mutual exclusion and deadlock detection in distributed systems
- Demonstrate the agreement protocols and fault tolerance mechanisms in distributed systems
- Describe the features of peer-to-peer and distributed shared memory systems

TEXT BOOK:

REFERENCES:

EVALUATION PATTERN:

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</table>
## Prerequisites for the course: None

### OBJECTIVES:
- To gain knowledge about various software development lifecycle (SDLC) models
- To appreciate the importance of requirements engineering in SDLC
- To be aware of designing a software, considering the various perspectives of the end user
- To learn to develop a software component using coding standards and facilitate code reuse
- To analyze the software using metrics and measurements and predict the complexity and the risk associated
- To appreciate appropriate software documentations across various SDLC stages

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**SUGGESTED ACTIVITIES:**
- In-class activity on Application specific Product and Process view
- External Learning on impact of unified process models on Quality Software Development and JIT software

**SUGGESTED EVALUATION METHODS:**
- Assignments: Selection of suitable software process models for a given software specification
- Tutorial problems: Identification of Sample Application for each process model and justify the same stating reasons.

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CMM – CMMI – PSP – TSP – ISO 12207 (Software Lifecycle), ISO 29148 (Requirements), ISO 15026 (Risk & Integrity), ISO 29119 (Testing), ISO 14764 (Maintenance), ISO 15939 (Measurement)

**SUGGESTED ACTIVITIES:**
- Need for organization wide standards adoption

**SUGGESTED EVALUATION METHODS:**
- Recalling the KPAs to be adhered for each level in CMM.
- Assignment on selection of appropriate standards for each phase in software development.

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Requirements Elicitation – Analysis & Negotiation – Requirements Modeling & Specification – Requirements Validation & Management

**SUGGESTED ACTIVITIES:**
- External Learning: Using open-source tools for RE to understand the requirements traceability and interdependency among the functionalities provided by the software project.

**SUGGESTED EVALUATION METHODS:**
- Tutorial on various Requirements elicitation mechanisms and selection of an appropriate strategy.
- Assignment on Requirements categorization (considering contradicting, omission, commission of requirements) in a software project.
### Data Modeling – Scenario Based Modeling

**SUGGESTED ACTIVITIES:**
- External Learning: Using open-source tools for Conceptual Data modeling of a Sample application

**SUGGESTED EVALUATION METHODS:**
- Assignment Data Modeling of sample application
- Assignment: Designing use case diagram and activity diagram to analyze the requirements obtained from the customer and segregate them as use cases and determine the possible set of activities from the end user.

### MODULE V:

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### Flow Oriented Modeling – Class Based Modeling – User Interface Design

**SUGGESTED ACTIVITIES:**
- External Learning: Use open source tools to perform Class Based Modeling for a given software requirements.

**SUGGESTED EVALUATION METHODS:**
- Assignment: Determine the flow of data/events among the processes in the application under consideration
- Assignment: Designing UI of Sample application
- Assignment: Design-to-code of Sample application involving coding standards

### MODULE VI:

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### Testing strategies


**SUGGESTED ACTIVITIES:**
- External Learning: Understanding the requirements (SRS) and designing a suitable test suite.
- External Learning: Determine valid interfaces for integration testing and design necessary stub and driver modules
- External Learning on ideas of testing a simple online application on selected test cases
- Tutorial on using Automation software for testing

**SUGGESTED EVALUATION METHODS:**
- Assignment on obtaining a mind-map on testing strategies
- Assignment: Testing of Sample application using any OSS on Software Test Automation

### MODULE VII:

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### Debugging Process

- Testing Tactics – Black-box approaches – Graph based testing Methods – Equivalence class partitioning – Boundary value analysis – Orthogonal array testing

**SUGGESTED ACTIVITIES:**
- In-class activity on Equivalence class partitioning
- In-class activity on Boundary value analysis
- External Learning on Software Test Documentation

**SUGGESTED EVALUATION METHODS:**
- Assignment: Testing Sample application using Black-box approaches and understand the differences in selecting of test cases from the test suite.
Testing Tactics – White-box approaches– Basis Path testing – Control Structure Testing

SUGGESTED ACTIVITIES:
- In-class activity on Basis Path testing
- In-class activity on Control-structure testing

SUGGESTED EVALUATION METHODS:
- Assignment: Testing Sample application for White-box approaches and understand how it differ from black box testing approaches.

MODULE IX:

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SUGGESTED ACTIVITIES:
- External Learning on using tools for estimating Software Cost

SUGGESTED EVALUATION METHODS:
- Tutorial: Identification of potential risks for a software project during development/maintenance and tabulate.
- Assignment: Using a Software Configuration Management template for a software project

MODULE X:

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SUGGESTED ACTIVITIES:
- External Learning on Software Quality Models
- In-class activity on FP metrics & Variants
- External Learning on Software Test Lifecycle

SUGGESTED EVALUATION METHODS:
- Assignment: Calculation of test metrics for sample application

OUTCOMES:
Upon completion of the course, the students will be able to:
- Point out the role and impact of software engineering in contemporary business, and global, economic, environmental and societal context
- Analyze and resolve information technology problems through the application of systematic approaches and diagnostic tools
- Analyze, design and manage the development of a computing-based system, component or process to meet the desired needs within realistic constraints in one or more application domains
- Use knowledge, techniques, skills and modern tools necessary for software engineering practice
- Engineer tools to analyze, evaluate, select and synthesize information sources for the purpose of developing a software system

TEXTBOOKS:
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Prerequisites: None

OBJECTIVES:
- To learn the architecture of the Intel 8086 microprocessor
- To familiarize with assembly language programming and learn to write programs in 8086 assembly
- To discuss the various multiprocessor configurations
- To understand the functionality and working of different peripheral chips and their interfacing to the processor
- To understand the architecture and the salient features of the x86 family of processors
- To familiarize with tools for program analysis and performance analysis

MODULE I:

Intel 8086 Microprocessors – Architecture – Internal operation - Instruction set – Assembler directives and operators – Addressing modes

SUGGESTED ACTIVITIES:
- In Class activity for 8086 instructions and addressing modes
- EL - Familiarising with the assembler
- Practical – 8086 simple programs on the assembler.

SUGGESTED EVALUATION METHODS:
- Assignment problems on basic arithmetic operations
- Quizzes

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8086- Assembly language programming - Stacks - Procedures – Macros – Interrupts and Interrupt service routines – Byte and String manipulation instructions

**SUGGESTED ACTIVITIES :**
- Flipped classroom and activity
- EL – Study of BIOS calls for keyboard and video services
- Practical – 8086 programs using procedures, macros and string manipulation instructions
  - Use of BIOS calls for video and keyboard services

**SUGGESTED EVALUATION METHODS:**
- Assignment problems for using the various string primitives
- Quizzes

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8086 Signals – Basic Configurations – Minimum mode - Maximum mode – Queue status and Lock Facility - System Bus Timing

**SUGGESTED ACTIVITIES :**
- EL - Minimum mode signals, some timing diagrams
- Practical – To continue with 8086 assembly language programming.

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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System design using 8086: Multiprocessor configurations – Coprocessor – Closely coupled and Loosely coupled configurations

**SUGGESTED ACTIVITIES :**
- Flipped Classroom
- EL- Basics of Loosely Coupled Configurations

**SUGGESTED EVALUATION METHODS:**
- Assignment problems on different types of configurations
- Quizzes

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Memory interfacing and I/O interfacing – Parallel communication Interface – Programming and Applications.

**SUGGESTED ACTIVITIES :**
- EL – Applications using 8255
- Practical - Implementation of various modes of operations of 8255 and applications

**SUGGESTED EVALUATION METHODS:**
- Assignment problems on memory interfacing and I/O interfacing in different configurations, System design using the 8086
- Quizzes
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<tr>
<td>Serial communication interface – Interrupt controller – DMA controller – programming and applications</td>
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**SUGGESTED ACTIVITIES:**
- EL – System design using these devices, Applications
- Practical - Implementation of various modes of operations of these devices

**SUGGESTED EVALUATION METHODS:**
- Assignment problems on applications and interfacing
- Quizzes

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<tr>
<td>IA 32 and IA 64 architectures - Evolution and salient features - Basic execution environment - System architecture overview - Modes of operation - Protected mode memory management.</td>
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**SUGGESTED ACTIVITIES**
- Flipped Classroom
- EL - evolution of the Intel processors
- Practical - Study of a typical program debugging tool
  - Create dis-assembly of a simple C program and identify the stack frame and its contents

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
- Report on the execution trace

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<tr>
<td>Paging - Address translation - Protection - Paging MMU cache - Demand paging and virtual memory management - Using segmentation and paging together. Privilege levels - Protection - Defining and changing privilege levels.</td>
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**SUGGESTED ACTIVITIES**
- Flipped classroom
- EL - Further explorations with the debugging tool
- Practical - Instrumentation and analysis with the tool

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
- Report based on the additional features

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<td>Multitasking - Task state segments - Scheduling - Changing privilege levels within a task - Communicating among tasks, Handling faults and interrupts.</td>
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**SUGGESTED ACTIVITIES**
- EL – Different types of exceptions and their handling
- Practical – Study of a performance analysis tool

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
MODULE X:

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Performance issues - Power and thermal management - Performance monitoring.

SUGGESTED ACTIVITIES:
- Flipped Classroom
- Practical - Performance monitoring with the tool and reporting the various parameters like the number of instructions, cache misses, context switches, etc.

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes
- Report on the findings of the performance tool for various scenarios

OUTCOMES:
Upon completion of the course, the students will be able to:
- Discuss the architecture of the 8086 processor in detail
- Write assembly language programs in 8086 assembly
- Show how multiple processors can be connected with an 8086 processor
- Show how the various peripheral chips can be interfaced to the processor
- Point out the salient features of the other processors in the x86 family and discuss the various modes of operation of these processors
- Generate CFGs for simple C programs using the dynamic instrumentation tools and generate performance statistics

TEXT BOOKS:

REFERENCES:

EVALUATION PATTERN:

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CS6306 PARALLEL PROGRAMMING

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**Prerequisites for the course:** NONE

**OBJECTIVES:**
- To identify the scope available for parallel programming over different models
- To identify the challenges in parallel programming
- To develop parallel programs using OpenMP in shared memory
- To develop parallel programs in distributed memory using MPI
- To program heterogeneous processors using CUDA and OPENCL

**MODULE I:**

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Introduction to Parallel Computing – Need for Parallel Computing – Concurrent, Parallel and Distributed Systems – The Von Neumann Architecture – Flynn's Taxonomy

**SUGGESTED ACTIVITIES:**
- In Class activity for Conversion of Simple Serial Problem to Parallel Problem

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE II:**

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**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- EL - Basics of Inter Process Communication (IPC)
- Practical - Programs on Interprocess Communication (Shared memory, Message Queue, Pipes)

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE III:**

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Interconnection Networks: Shared Memory Interconnects - Distributed Memory Interconnects – Parallel Software – Identifying Potential Parallelism – Techniques for Parallelizing Programs
SUGGESTED ACTIVITIES:
- EL – Basics of Interconnection Networks
- In class activity to identify techniques for parallelizing the program

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Performance: Speedup and Efficiency – Amdahl’s Law – Scalability – Parallel Program Design – Writing and Running Parallel Programs.

SUGGESTED ACTIVITIES:
- EL - Writing simple parallel programs
- In class activity for speed and efficiency calculation
- Practical - Analyzing and comparing the speedups on serial and parallel programs

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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SUGGESTED ACTIVITIES:
- Flipped Class room
- EL – Basics of cache principles

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

MODULE VI:
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SUGGESTED ACTIVITIES:
- EL – Introduction to OpenMP
- Practical - Programs on OpenMP and Applications on OpenMP

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

MODULE VII:
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SUGGESTED ACTIVITIES:
- EL – Introduction to MPI
- Practical - Programs on MPI

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Other MPI Features – Asynchronous Communication – Performance Issues – Combining OpenMP and MPI.

SUGGESTED ACTIVITIES:
- Combinations of in Class & Flipped class rooms
- EL – Applications of OpenMP and MPI
- Practical - Applications on MPI

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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SUGGESTED ACTIVITIES:
- Flipped classroom
- EL – Basics of GPU and Applications of CUDA
- Practical - Programs on CUDA

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Introduction to OpenCL – Benefits of OpenCL- Anatomy of OpenCL – OpenCL Architecture – Application development using OpenCL

SUGGESTED ACTIVITIES:
- Mostly in Class
- EL – Applications of OpenCL
- Practical - Programs on OpenCL.

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Tutorial problems

OUTCOMES:
Upon completion of the course, the students will be able to:
- Point out the fundamental concepts of parallelism
- Discuss the challenges in parallel programming
- Parallelize a serial program and point out the advantages and overheads
- Implement parallel programs with OpenMP and MPI
Develop parallel programs in a heterogeneous processor using OpenCL and CUDA

**TEXT BOOKS**

**REFERENCES:**
6. MPI Programmer’s Manual

**EVALUATION PATTERN:**

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**CS6307 ADVANCED ALGORITHMS**

**Prerequisites for the course:** Data Structures & Algorithms

**OBJECTIVES:**

- To familiarize with the main thrust areas in algorithms that will be sufficient for formulating and seeking known solutions to an algorithmic problem
- To understand how to formulate an approximation algorithm for an NP-complete problem
- To introduce the key concepts, problems, techniques and data structures within Computational Geometry
- To understand and analyze multithreading and parallel algorithms
- To learn linear programming models

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**MODULE I**

PRAM Models–List Ranking - Prefix sum - Sorting - Sum - Bitonic sort.

**SUGGESTED ACTIVITIES:**
- EL - Study of one or two problems having parallel solutions
- Practicals – Implementation of list ranking, prefix sum and bitonic sort using C with MPI
- Analysis of suitable PRAM models

**SUGGESTED EVALUATION METHODS:**
- Assignment - Based on EL
- Demonstration of programs

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**SUGGESTED ACTIVITIES:**
- EL – Study atleast two problems on any of the DCM
- Practicals – Implementation of sorting and matrix multiplication on 2D mesh using C with MPI

**SUGGESTED EVALUATION METHODS:**
- Assignment - Based on EL
- Demonstration of programs

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Prefix sum on: 2D Mesh - Butterfly. Sum on: 2D Mesh - Butterfly.

**SUGGESTED ACTIVITIES:**
- EL - Based on suggested reading by the course instructor
- Practical – Implementation of prefix sum and sum on 2D mesh using C with MPI

**SUGGESTED EVALUATION METHODS:**
- Assignment: Based on EL
- Quizzes: Based on first three modules
- Demonstration of programs

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Geometric Algorithms: Segment trees - kd-trees - 1D and 2D Range Search.

**SUGGESTED ACTIVITIES:**
- EL: Problems on segment trees and range search
- Practical – Implementation of segment trees

**SUGGESTED EVALUATION METHODS:**
- Based on EL
- Demonstration of programs

**MODULE V**  
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Line Segment Intersection - Closest Pair of Points - Range Trees – Voronoi diagram.

**SUGGESTED ACTIVITIES:**
- EL – Study of Voronoi diagram
- Practical – Implementation of line segment intersection and Voronoi diagram

**SUGGESTED EVALUATION METHODS:**
- Demonstration of programs

**MODULE VI**  
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Randomized Algorithms: Introduction - Randomized Selection - Randomized sorting.

**SUGGESTED ACTIVITIES:**
- Flipped Classroom – Types of Randomized Algorithms and analysis
- Practical – Implementation of randomized selection and quick sort

**SUGGESTED EVALUATION METHODS:**
- Quizzes: Based on Modules IV, V and VI
- Demonstration of programs

**MODULE VII**  
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Approximation Algorithms: Vertex cover - Metric TSP- Set Covering Problem

**SUGGESTED ACTIVITIES:**
- Assignment

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

**MODULE VIII**  
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NP Complete: Clique Problem - Subset Sum Problem

**SUGGESTED ACTIVITIES:**
- EL – Studying proof for atleast one NP complete problem

**SUGGESTED EVALUATION METHODS:**
- Based on EL

**MODULE IX**  
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**SUGGESTED ACTIVITIES:**
- Quiz
- Practical – Implementation of multithreaded algorithms

**SUGGESTED EVALUATION METHODS:**
- Quizzes: Based on Modules VII, VIII and IX
- Demonstration of programs

**MODULE X**  
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Solving system of linear equations - Simplex algorithm – Duality.
SUGGESTED ACTIVITIES:
- Assignments
- Practical – Implementation of simplex algorithm

SUGGESTED EVALUATION METHODS:
- Assignments
- Demonstration of programs

OUTCOMES:
Upon completion of the course, the students will be able to:
- Comprehend and propose algorithms for any given problem
- Construct and implement algorithms for simple geometrical problems
- Perform the design of parallel and multithreading algorithms
- Find approximate solution to a hard problem
- Formulate a linear programming model for a given problem

TEXTBOOKS:

REFERENCES:

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CS6308 JAVA PROGRAMMING

Pre-requisites: None
OBJECTIVES:
- To learn about the fundamentals of Java language constructs
- To familiarize the student with Object Oriented Programming in Java
- To expose the student to creating UI
- To understand the concepts of parallel programming
- To develop web applications with Java

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Introduction to Java, Java basics – Variables, Operators, Expressions, Control flow Statements, Methods, Arrays

SUGGESTED ACTIVITIES:
- Practical-Implementation of simple Java programs Using Java Basic Constructs and Arrays using any standard IDE like NETBEANS / ECLIPSE
- EL – Understanding JVM

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Classes and Objects, Constructor, Destructor, Static instances, this, constants, Thinking in Objects, String class, Text I/O

SUGGESTED ACTIVITIES:
- Flipped classroom
- Practical - Implementation of Java programs – using String class, Creating Classes and objects
- EL – Thinking in Objects

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Inheritance and Polymorphism – Super classes and sub classes, overriding, object class and its methods, casting, instance of, Array list, Abstract Classes, Interfaces, Packages, Exception Handling

SUGGESTED ACTIVITIES:
- Flipped classroom
- Practical - implementation of Java programs – use Inheritance, polymorphism, abstract classes and interfaces, creating user defined exceptions
- EL – dynamic binding, need for inheritance, polymorphism, abstract classes and interfaces

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

<table>
<thead>
<tr>
<th>MODULE IV</th>
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</thead>
</table>

124
Creating UI, Frames, layout manager, Panels, components, Event Driven Programming

**SUGGESTED ACTIVITIES:**
- flipped classroom
- Practical – Mouse, key events, creating interactive forms using AWT/Swing and adding functionality
- EL – Understand AWT and SWING

**SUGGESTED EVALUATION METHODS:**
- Quizzes

### MODULE V I/O STREAMS

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I/O Streams, binary I/O

**SUGGESTED ACTIVITIES:**
- Practical - binary streams, file streams
- EL – Lambdas and Streams

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### MODULE VI MULTITHREADING

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Multithreading – states, synchronization, avoiding deadlocks

**SUGGESTED ACTIVITIES:**
- Practical – implementing threads
- Flipped Classroom
- EL – Parallel Programming

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### MODULE VII NETWORKING AND DATABASE CONNECTIVITY

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Java Networking – Inet address class, Sockets, JDBC

**SUGGESTED ACTIVITIES:**
- Flipped class room
- Practical – Using Socket, Developing simple applications using JDBC
- EL – Internationalization

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### MODULE VIII FRAMEWORKS

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Collections Frameworks – lists, vector and stack classes, Generics,

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- Practical - Using Generic classes and Collections framework, Using Comparative interface, list, stack
- EL - Code Annotations

**SUGGESTED EVALUATION METHODS:**
• Assignment problems
• Quizzes

**MODULE IX**  WEB DEVELOPMENT - 1  

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Applets, Servlets / JSP

**SUGGESTED ACTIVITIES**:
- Flipped class room
- Practical - Implementations of Java programs – Creating applets, servlets, JSP
- EL – Java based web servers

**SUGGESTED EVALUATION METHODS**:
- Assignment problems
- Quizzes

**MODULE X**  WEB DEVELOPMENT - 2  

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JSF, RMI, Web services

**SUGGESTED ACTIVITIES**:
- Flipped class room
- Practical - Implementations of Java programs – Creating UI with JSF, Implementing RMI
- EL – creating UI with JSF

**SUGGESTED EVALUATION METHODS**:
- Quizzes

**OUTCOMES:**
Upon completion of the course, the students will be able to:
- Use NETBEANS or equivalent open source editors for Java programming
- Create and use Java Objects for applications related to object oriented concepts
- Demonstrate networked Java Applications using Java Sockets and JDBC
- Implement Multithreading and create rich UI
- Implement and deploy web applications using Java

**TEXT BOOKS:**

**REFERENCES:**

**Web references:**
1. NPTEL
2. MIT OCW

**EVALUATION PATTERN:**

<table>
<thead>
<tr>
<th>Category of Course</th>
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**CS6001 DATA MINING**

**Prerequisites for the course:** None

**OBJECTIVES:**

- To understand and interpret the contribution of data mining to decision support in various organizations.
- To categorize and carefully differentiate between situations for applying different data-mining techniques: frequent pattern mining, association, correlation, classification, prediction, and cluster and outlier analysis.
- To provide an overview of the developing areas - Graph mining, Multi-relational analysis, and Social Network mining.
- To propose data-mining solutions for different applications.
- To highlight the importance of applying data mining techniques compared to the traditional methods.

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**MODULE I:**

Introduction to Data Mining: Data Mining – Roots – Process – Large Datasets – DW for Data Mining, Stages of the Data Mining Process- Task Primitives, Data Mining Techniques - Data Mining Knowledge Representation – Data Mining Query Languages, Business Aspects of Data Mining

**SUGGESTED ACTIVITIES:**

- Discussion: Issues& Challenges

**SUGGESTED EVALUATION METHODS:**

- Quizzes

| MODULE II | | | | | |
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**SUGGESTED ACTIVITIES:**

- Flipped classroom and activity
- EL – Practical Problems
- Practical - Implementation of data preprocessing techniques

**SUGGESTED EVALUATION METHODS:**

- Tutorial problems
- Assignment problems
- Quizzes

| MODULE III | | | | | |
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Mining Frequent Patterns, Associations and Correlation: Market-Basket Analysis – Apriori Algorithm, Frequent Itemset Mining Methods, Frequent Itemsets to Association Rules, From Association Mining to Correlation Analysis, Constraint-Based Association Mining – Multidimensional Association
<table>
<thead>
<tr>
<th>Module</th>
<th>Suggested Activities</th>
<th>Suggested Evaluation Methods</th>
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<tbody>
<tr>
<td>IV</td>
<td>EL - Frequent-Pattern Mining in Data Streams, Practical - Implementation of Frequent Pattern Mining Techniques</td>
<td>Tutorial problems, Assignment problems, Quizzes</td>
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<tr>
<td></td>
<td>Classification: Classification, Issues, Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Back Propagation, Support Vector Machines, Association Classification, Lazy Learners, Ensemble Methods, Performance Measures</td>
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<tr>
<td>V</td>
<td>Flipped Class room, EL - Classification of Dynamic Data Streams, Practical - Implementation of Classification Techniques</td>
<td>Tutorial problems, Assignment problems, Quizzes</td>
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<td>Prediction: Prediction, Issues, Linear Regression, Non-Linear Regression, Generalized Linear Models, Regression Trees, Performance Measures</td>
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<td>Applications in class, EL – Performance Measures, Practical - Implementation of Prediction Techniques</td>
<td>Tutorial problems, Assignment problems, Quizzes</td>
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<td>Clustering Concepts, Similarity Methods: Partitioning Methods: k-means, Hierarchical Methods: Distance-based Agglomerative and Divisible Clustering, Density-Based Methods, Model-Based Methods: Expectation Maximization, Grid Based Methods, Constraint-Based Cluster Analysis, Outlier Analysis, Clustering large database</td>
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<tr>
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<td>Flipped Classroom for further study, Practical - Implementation of Clustering Techniques</td>
<td>Tutorial problems, Assignment problems, Quizzes</td>
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</table>
SUGGESTED ACTIVITIES:
- Combinations of in Class & Flipped class rooms
- Seminars on Applications
- Practical - Implementations of Social Network Analysis
- EL – Mining Frequent Subgraphs

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Graph Mining and Social Network Analysis: Methods for Mining Frequent Subgraphs, Mining Variant and Constrained Substructure Patterns, Social Network Analysis, Multi-relational Data Mining: Multi-relational Classification using Inductive Logic Programming, Multi-relational Classification using Tuple ID Propagation, Multi-relational Clustering with User Guidance

SUGGESTED ACTIVITIES:
- Combinations of in Class & Flipped classroom
- Practical

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Mining Complex data objects: Spatial Data Mining, Multimedia Data Mining, Distributed Data Mining Text Data Mining, Mining the World Wide Web

SUGGESTED ACTIVITIES:
- Combinations of in Class & Flipped classroom
- EL – Mining the Web

SUGGESTED EVALUATION METHODS:
- Assignments
- Quizzes

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Applications and Trends in Data mining: Applications-Decisions involving judgments, Screening Images, Load forecasting, Diagnosis, Marketing, Sales & financial domains, Bio-medical ; Trends in Data Mining

SUGGESTED ACTIVITIES:
- Combination of in class & Flipped
- Seminars
- Demos
- EL – Mini project

SUGGESTED EVALUATION METHODS:
- Project demonstration and presentation

TEXT BOOK
REFERENCES:

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:
- Demonstrate the knowledge of the ethical considerations involved in Data Mining.
- Examine data and select suitable methods for data analysis.
- Integrate various Classification, Clustering, Association rule mining techniques on real world data.
- Synthesize the different algorithms and analyze it with the support of tools.
- Interpret the concept of Spatial, Multimedia and Distributed, text and web mining and able to retrieve the data, analyze and make decision.

EVALUATION PATTERN:

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<th>Continuous assessment</th>
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CO-PO MAPPING

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Prerequisites for the Course: None

OBJECTIVES:
- To learn different soft computing approaches
- To learn the fundamental concepts of Fuzzy logic and apply them to different domains
- To learn the fundamental concepts of Genetic Algorithms and apply them to different domains
- To learn the fundamental concepts of Neural Networks
- To learn the different types of Neural Networks and apply them to different domains

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</table>
  - Flipped classroom
  - EL - Classification, clustering, optimization in real world
  - In class activity - Mapping classification, clustering and optimization to soft computing techniques
| SUGGESTED EVALUATION METHODS: |
  - Tutorial problems
  - Quiz
  - Reflection journal

| MODULE II | | 3 | 0 | 0 | 3 |
| Introduction to Fuzzy logic - Fuzzy membership functions - Operations on Fuzzy sets - Fuzzy relations - Fuzzy propositions - Fuzzy implications |
| SUGGESTED ACTIVITIES: |
  - Flipped classroom and activity
  - EL - Solving real world problems
| SUGGESTED EVALUATION METHODS: |
  - Tutorial problems
  - Assignment problems
  - Quizzes

| MODULE III | | 4 | 0 | 0 | 3 |
| Fuzzy inferences - Defuzzification techniques - Fuzzy logic controller - Decision making - Fuzzy pattern recognition - Optimization problems |
| SUGGESTED ACTIVITIES: |
  - Flipped classroom and activity
  - In class activity - Numerical example problem solving
  - Practical - Simulation of optimization and pattern recognition problems
| SUGGESTED EVALUATION METHODS: |
- Tutorial problems
- Assignment problems
- Practical simulation problems
- Quizzes
- Reflection journal

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Fuzzy logic controller - Fuzzy logic applications in Computer Science - Decision making - Fuzzy pattern recognition - Optimization problems

SUGGESTED ACTIVITIES:
- Flipped classroom and activity
- In class activity - Numerical example problem solving
- Practical - Simulation of optimization and pattern recognition problems

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Practical simulation problems

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Genetic Algorithm - Operators - Selection - Mutation - Optimization Techniques

SUGGESTED ACTIVITIES:
- Flipped Class room
- Inclass activity - Solving Numerical Real world problems with GA opearators
- Practical - Programming exercises

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems

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Kinematics - Particle swarm optimization - Artificial Life - Genetic Fuzzy model

SUGGESTED ACTIVITIES:
- Applications in class
- Practical - Simulation of optimization techniques

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Artificial Neural Networks - Neuron model - Basic learning rules - Multilayer neural networks and backpropagation

SUGGESTED ACTIVITIES:
- Flipped classroom
- In class activity - Numerical problem solving
- Practical - Simulation of learning

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
● Quizzes
● Reflection journal

**MODULE VIII**

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Associative memory - Self organizing neural network - RBF neural network - Neuro Fuzzy models

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- Inclass - Solving numerical examples
- Practical - Implementation of auto associative memory model and Self-organizing maps

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
- Reflection journal

**TEXTBOOKS:**

**REFERENCES:**

**OUTCOMES:**
Upon completion of the course, the students will be able to:
- Discuss the theoretical background of Fuzzy Logic
- Analyse the optimization and clustering problems with Fuzzy Logic
- Present the theoretical background of Genetic Algorithm
- Apply Genetic Algorithms for optimization problems
- Present the theoretical background of Artificial Neural Networks
- Implement the algorithms on Artificial Neural Networks for Classification and Clustering problems.

**CO-PO Mapping**

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133
CS6003  BIG DATA ANALYTICS

Prerequisites for the course: None

OBJECTIVES:
- To know the fundamental concepts of big data and analytics.
- To explore tools and practices for working with big data
- To learn about stream computing.
- To know about the research that requires the integration of large amounts of data.

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SUGGESTED ACTIVITIES:
- EL- Big Data Usecases
- Quizzes
- Practicals
- Assignment problems
- Quizzes
- Tutorial problems
- Flipped classroom and activity
- Practical on MapReduce application for word counting on Hadoop cluster
- Introduction to YARN and EL based on that

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes
### MODULE IV: CLASSIFICATION

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- Decision Trees - Overview of a Decision Tree - The General Algorithm - Decision Tree Algorithms - Evaluating a Decision Tree - Decision Trees in R - Naïve Bayes - Bayes' Theorem - Naïve Bayes Classifier.

**SUGGESTED ACTIVITIES:**
- Flipped Class room
- EL-Basics of R programming

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems

### MODULE V: ASSOCIATION

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**SUGGESTED ACTIVITIES:**
- Applications in class
- Flipped Class room

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems on Apriori algorithm
- Assignment problems

### MODULE VI: RECOMMENDATION SYSTEM

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- Collaborative Recommendation - Content Based Recommendation - Knowledge Based Recommendation - Hybrid Recommendation Approaches.

**SUGGESTED ACTIVITIES:**
- Mini project on Recommendation Systems using Hadoop libraries
- Flipped Classroom for further study

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Project demonstration and presentation

### MODULE VII: GRAPH MEMORY

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- Using Graph Analytics for Big Data: Graph Analytics - The Graph Model - Representation as Triples-Graphs and Network Organization - Choosing Graph Analytics - Graph Analytics Use Cases - Graph Analytics Algorithms and Solution Approaches - Technical Complexity of Analyzing Graphs - Features of a Graph Analytics Platform - Considerations: Dedicated Appliances for Graph

**SUGGESTED ACTIVITIES:**
- Combinations of in Class & Flipped class rooms
- EL on Graph Analytics Use Cases

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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135
### MODULE VIII: STREAM MEMORY

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**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL-Case study on Real time Analytics Platform (RTAP)

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE IX: NOSQL DATA MANAGEMENT FOR BIG DATA

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NoSQL Databases: Schema-less Models: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases-Hive - Sharding -- Hbase

**SUGGESTED ACTIVITIES:**
- Introduction to Hive and EL based on that
- Practical-Unstructured data into NoSQL data and do all operations such as NoSQL query with API.

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

### MODULE X: VISUALIZATION AND TRENDS

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**SUGGESTED ACTIVITIES:**
- Combination of in class & Flipped
- EL- Big data for blogs
- Practical- Data analytics in R

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

---

**TEXT BOOKS:**
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
• Work with big data tools and its analysis techniques
• Analyze data by utilizing clustering and classification algorithms
• Learn and apply different mining algorithms and recommendation systems for large volumes of data
• Perform analytics on data streams
• Work with NoSQL databases and management

EVALUATION PATTERN

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CS6004 INFORMATION VISUALIZATION

Prerequisites for the course: None

OBJECTIVES:
• To understand data collection and representation
• To analyze real-time problems and identify tasks
• To study the levels of validation
• To learn to define and use, marks and channels
• To understand the various techniques of visualization

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**MODULE I:**

**SUGGESTED ACTIVITIES:**
- EL – Case study for visualization
- Objects that can be used for visualization
- Data Collection for any one domain – Societal, Technical domains

**SUGGESTED EVALUATION METHODS:**
- Assignment activity
- Group activity
- Quizzes

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Task Abstraction – Analyze tasks abstractly – Designer or User – Actions – Targets – Analyzing and Deriving: examples

**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- EL – Practical Problems – Task identification for real-time problems or any one problem for which data collection has been done

**SUGGESTED EVALUATION METHODS:**
- Assignment activity
- Group activity
- Quizzes

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Four Levels for Validation – Validate – Four Levels of Design – Angles of Attack – Threats and Validation approaches - Examples

**SUGGESTED ACTIVITIES:**
- Practical activity – Data validation approaches for any one domain
- Group activity – discussion on methods of data validation – their pros and cons

**SUGGESTED EVALUATION METHODS:**
- Assignment activity
- Group activity
- Quizzes

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Data Abstraction – Semantics vs Types – Attribute types – Dataset types – Attribute Semantics – Dataset Semantics – Derived and Transformed Data - Marks and Channels – Defining Marks and
Channels – Using Marks and Channels

**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- Visualization aspects
- Group activity – Data type identification

**SUGGESTED EVALUATION METHODS:**
- Assignment activity
- Quizzes

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Channel Effectiveness – Relative vs Absolute Judgments - Dynamic Design Principles – Classes of Change – Latency and Feedback – Interactivity Costs – Memory and Attention – Spatial Cognition

**SUGGESTED ACTIVITIES:**
- Group activity – day to day objects for visualization – Kolams, traffic light, etc.,
- Practical activity – Real life examples for Classes of change
- Group activity – using dynamic design principles

**SUGGESTED EVALUATION METHODS:**
- Assignment activity
- Group activity
- Quizzes

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Rules of Thumb – Unjustified 3D – Unjustified 2D – Eyes beat Memory – Resolution over Immersion – Zoom and Filter, Details on Demand – Responsiveness is required- Get it right in Black and White – Function first, Form next

**SUGGESTED ACTIVITIES:**
- Flipped classroom – Project selection
- Project discussion – Group activity

**SUGGESTED EVALUATION METHODS:**
- Assignment activity
- Group activity
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Project Discussion
- Real-time objects and their orientation methods – group activity

**SUGGESTED EVALUATION METHODS:**
- Assignment activity
- Group activity
- Quizzes

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Arrange Networks and Trees – Link Marks – Matrix Views – Costs and Benefits: Connection vs Matrix – Containment : Hierarchy – Map color and other Channels – The Big Picture – Color Theory –
### SUGGESTED ACTIVITIES:
- Trees and linking to the project activity
- Color theory – Practical applications

### SUGGESTED EVALUATION METHODS:
- Assignment activity
- Group activity
- Quizzes

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### MODULE IX:

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### SUGGESTED ACTIVITIES:
- Sample views for real world problems
- EL – group activity – real-world problem identification and their activity
- Case studies – Graph, VisDB, Hierarchical Clustering

### SUGGESTED EVALUATION METHODS:
- Assignment activity
- Group activity
- Quizzes

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### MODULE X:

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### SUGGESTED ACTIVITIES:
- Project progress
- Case studies – Pivot Graph, Interring, Constellation
- Combination of in class & Flipped
- EL – Other Applications
- Practical – Mini Project

### SUGGESTED EVALUATION METHODS:
- Project documentation and demo

---

**TEXT BOOK:**

**REFERENCES:**

**OUTCOMES:**
Upon completion of the course, the students will be able to:
- Perform data collection and representation
- Identify the task and analyze the real time problems
- Study the levels of validation
- Define and use, marks and channels
- Perform various techniques of visualization
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CS6005 DEEP LEARNING TECHNIQUES
Prerequisites for the course: Machine Learning

OBJECTIVES:
- To learn the basic principles of supervised and unsupervised learning
- To provide basic understanding of the concepts involved in deep learning
- To understand the difference and similarities between the various forms of deep neural networks
- To have knowledge about deep generative models.
- To know about the applications of deep learning techniques in various real-time problems

CS6005 DEEP LEARNING TECHNIQUES

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MODULE I:

SUGGESTED ACTIVITIES:
- EL – Fundamentals of Linear Algebra
- In Class activity for linear algebra
- EL – Learn to implement machine learning algorithms

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE II:

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**Neural Networks – The Biological Neuron – The Perceptron – Multilayer Feed-Forward Networks - Training Neural Networks – Activation Functions – Loss Functions – Hyperparameters**

**SUGGESTED ACTIVITIES:**
- Flipped classroom and activity
- EL – Practical Problems –Bias, Variance and Maximum likelihood estimation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Deep learning - Deep feed forward networks – Architecture design - Gradient based learning – Back propagation and other differentiation algorithms -

**SUGGESTED ACTIVITIES:**
- Neural Networks - EL

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Flipped Class room
- Introduction to Deep Learning – in class and EL based on that

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Unsupervised Pretrained Networks - Deep Belief Networks - Generative Adversarial Networks – Convolutional Neural Networks(CNNs) - CNN Architecture Overview - Other Applications of CNNs.

**SUGGESTED ACTIVITIES:**
- EL – Belief Networks
- Applications of CNN in class

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Recurrent Neural Networks (RNN) - General RNN Architecture - LSTM Networks – Recursive Neural Networks - Architecture - Applications.
### SUGGESTED ACTIVITIES:
- Introduction in class
- Flipped Classroom for applications

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE VII:

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Linear Factor Models – Probabilistic PCA and Factor Analysis – Independent Component Analysis (ICA) – Slow Feature Analysis – Sparse Coding – Manifold Interpretation of PCA.

### SUGGESTED ACTIVITIES:
- Combinations of in Class & Flipped class rooms
- EL - Probabilistic PCA and Factor Analysis

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Under complete and Regularized auto encoders – Contradictive auto encoders – Transfer learning and domain adaptation

### SUGGESTED ACTIVITIES:
- Flipped classroom
- EL on Sampling
- Practical – Mini Project

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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### SUGGESTED ACTIVITIES:
- Mostly in Class
- EL – Deep Generative Models
- Practical – Mini Project

### SUGGESTED EVALUATION METHODS:
- Assignment problems
- Tutorial problems

### MODULE X:

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Large Scale Deep Learning – Computer Vision – Speech Recognition – Natural Language Processing – Other Applications

### SUGGESTED ACTIVITIES:
- Combination of in class & Flipped
- EL – Other Applications
Practical – Mini Project

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Differentiate the various deep neural network models
- Design systems by applying appropriate deep neural networks concepts
- Analyse and provide modification to deep learning principles to suit any application
- Justify the need for Boltzmann machine principles for a target application
- Apply deep learning concepts for any target application

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Prerequisites for the course: None

OBJECTIVES:
- To learn the concepts of cloud computing
- To provide an in-depth knowledge of the cloud computing fundamentals, technologies, applications and implementations.
- To expose the students to the cloud working methodology through virtualization, and networking techniques including SDN and NFV
- To motivate students to do programming and experiment with the various cloud computing environments and platforms.
- To shed light on the security issues in cloud computing.
- To appreciate the emergence of the next generation computing paradigm based on cloud.

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SUGGESTED ACTIVITIES:
- Use Google Collaboration Tools: Create Google Docs, Sheets, and Slides and share it with others
- Explore public cloud services including Amazon, Google, Salesforce, and Digital Ocean.

SUGGESTED EVALUATION METHODS:
- Quiz
- Report Submission – Comparison of various services provided by different Cloud Service Provider (Configuration of VM, Cost, Network Bandwidth etc…)

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SUGGESTED ACTIVITIES:
- Create a simple Web Service using Python Flask /Java [Web Service: Client-server model should be implemented using socket/http]

SUGGESTED EVALUATION METHODS:
- Quiz on various concepts of the Module
- Flipped classroom
- Review of the Web Service Implementation – Proper Connection should be established between the client and server to make use of the service offered by the Server.

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SUGGESTED ACTIVITIES:
- Install Oracle Virtual Box/VMware Workstation and Create a Blackboard Application [Hint: One VM should act as a master and other VMs acts as a listeners, when any content is written by the master VM, the content should be displayed in all the Listener VMs]
• Install KVM / Xen and create VM using image templates

SUGGESTED EVALUATION METHODS:
• Quiz on various concepts of the Module
• Flipped classroom
• Assessing of the working of installed Virtualization Tools.
• Review of the working of Blackboard Application in virtual environment [Implemented using basic echo and chat concepts ]

MODULE IV

Open Source Cloud Platforms

Features of Cloud platforms- Overview of various open-source platforms –Eucalyptus and OpenNebula- Insight into OpenStack Architecture and Components

SUGGESTED ACTIVITIES:
• Learn architecture and features of Eucalyptus and OpenNebula
• Install and configure OpenStack all-in-one using Devstack/Packstack
• Launch VMs in OpenStack through dashboard

SUGGESTED EVALUATION METHODS:
• Quiz on various concepts of the Module
• Flipped classroom
• OpenStack Dashboard should be accessible through web browser and the working of instance must be verified by logging in to it /pinging the instance.

MODULE V

Cloud Storage and Containers

Introduction to Cloud Storage, Definition, Provisioning -Unmanaged and Managed cloud storage - Creating cloud storage systems --Cloud Backup types, Features -Cloud attached backup -Cloud Storage Interoperability, CDMI, OCCI-Introduction to containers -Overview of Dockers

SUGGESTED ACTIVITIES:
• Explore volumes and its functions in OpenStack – creating volume, snapshots and other activities.
• Install Docker and run “hello world” docker instance

SUGGESTED EVALUATION METHODS
• Quiz on various concepts of the Module
• Flipped classroom
• OpenStack activity is to be appropriately verified
• Working of Docker must be tested by running the simple command “docker run hello-world”.

MODULE VI

Cloud Security


SUGGESTED ACTIVITIES:
• Secure the OpenStack cloud instances by adding one’s own rule to security groups.
• Use any free security tools (e.g., ACUNETIX, ETTERCAP) to scan web applications on the cloud, cloud networks for finding vulnerabilities, verifying leakage of information to an unauthorized third party.

SUGGESTED EVALUATION METHODS:
• Quiz on various concepts of the Module
• Flipped classroom
• Report Submission – Take the screenshot of the list of rules added in the security groups and justify the necessity of the each and every added rule.
• Report Submission - Generate a detailed report describing vulnerabilities along with the suitable action that can be taken to remedy the loopholes.

MODULE VII

Cloud Platforms in Industry

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</table>
Parallel Programming Paradigm - Apache Hadoop and Map-Reduce - MapReduce Programming Model - Major MapReduce Implementations for the Cloud - Public Cloud Platforms: GAE, AWS, and Azure - Programming Google App Engine - Programming on EC2, S3 - Best Practices in Architecting Cloud Applications in the AWS Cloud

**SUGGESTED ACTIVITIES:**
- Install and configure Apache Hadoop (single node) and run a simple problem (e.g., word count)
- Install GAE
- Build and deploy a simple web application / host a static website on Google App Engine / Heroku

**SUGGESTED EVALUATION METHODS:**
- Quiz on various concepts of the Module
- Flipped classroom
- Hadoop installation must be checked by running the simple problem with appropriate inputs
- Working of web application must be tested in browser by entering the unique URL assigned by Google App Engine / Heroku to the web app.

**MODULE VIII**

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**SUGGESTED ACTIVITIES:**
- Explore Amazon CloudWatch, Nagios, Hyperic Management and Monitoring Tools and use on an application

**SUGGESTED EVALUATION METHODS:**
- Quiz on various concepts of the Module
- Report Submission - Detailed Report should be given with the details of the available resources and used resources (CPU, RAM, N/W bandwidth and storage) of the application.

**MODULE IX**

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Use of Clouds for HPC/HTC and Ubiquitous Computing - Performance Metrics for HPC/HTC Systems - Quality of Service in Cloud Computing

**SUGGESTED ACTIVITIES:**
- Mini Project
  - Build your own Docker Web Application Image and push it into docker hub image repository
  - Setup a private cloud for device monitoring and control using OpenStack.
  - Create a private cloud and take automatic snapshot/backup of machines/virtual machines based on predefined conditions (e.g., timely backup, event-based backup etc.)
  - Create a Hadoop application and extract important and relevant information (like max/min recorded temperature in particular year or number of patients in a year) in large weather/medical datasets.

**SUGGESTED EVALUATION METHODS:**
- Quiz on various concepts of the Module
- Mini project demonstration

**MODULE X**

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An Architecture for Federated Cloud (Inter-Cloud) Computing - Inter-Cloud Resource Management - Introduction to Fog Computing

**SUGGESTED ACTIVITIES:**
- Mini Project
  - Create a private cloud and take automatic snapshot/backup of machines/virtual machines based on predefined conditions (e.g., timely backup, event-based backup etc.)
  - Create a Hadoop application and extract important and relevant information (like max/min recorded temperature in particular year or number of patients in a year) in large weather/medical datasets.
weather/medical datasets.

**SUGGESTED EVALUATION METHODS:**
- Quiz on various concepts of the Module
- Mini project demonstration

**TEXT BOOKS:**

**REFERENCES:**

**OUTCOMES:**
Upon Completion of the course, the students will be able to:
- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
- Discuss the core issues of cloud computing such as resource management and security.
- Install and use current cloud technologies.
- Establish their own cloud environment using OpenStack and work on it.

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CS6007 INFORMATION SECURITY

Prerequisites for the course: None

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OBJECTIVES:
- To know the various forms of attacks
- To understand the risk management and framing of various security models.
- To learn, to protect using physical secure design and cryptographic techniques
- To know the standard algorithms used to provide authentication and authorization
- To understand real world security protocols

MODULE I: INFORMATION SYSTEM

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<td>Introduction to Information Systems</td>
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SUGGESTED ACTIVITIES:
- EL - Prepare an information system for any organization. Consider an organization, prepare a table consisting of functional components of the organization, purpose of the components and Hardware & software supporting for the functional component.
- Draw an overall information model consisting of all the functional component of an organization.

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE II: SOFTWARE ATTACKS

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<td>Use of Malware - Virus - Worm - Trojan Horse - Logic Bomb - Rootkit - Spyware - Adware - Password Cracking - DoS and DDoS - Spoofing - Sniffing - Man-in-Middle Attack - Phishing - Pharming.</td>
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SUGGESTED ACTIVITIES:
- Consider each functional component and prepare a table consisting of possible vulnerabilities list of malware, adware and attacks and appropriate solution to prevent the attacks.
- A discussion wall may be created and ask the student to discuss the different attacks of information system
- Ask the student group to identity the kind of threat and attack for a case where security breach occurred in the fraudulent transactions (Collaborative Learning)
- EL – DoS and DDoS

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE III: RISK MANAGEMENT

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SUGGESTED ACTIVITIES:
- Consider each functional component and prepare a table consisting of possible vulnerabilities list of malware, adware and attacks and appropriate solution to prevent the attacks.
- A discussion wall may be created and ask the student to discuss the different attacks of information system
- Ask the student group to identity the kind of threat and attack for a case where security breach occurred in the fraudulent transactions (Collaborative Learning)
- EL – DoS and DDoS

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE IV : SECURITY MODELS**

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**SUGGESTED ACTIVITIES :**
- EL to identify the Risk Determination.
- Tutorial problems
- Assignment problems
- Quizzes

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE V : Physical Security Design**

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Security Technology - Digital certificate - Digital Signatures - Firewall – Firewall Configuration Strategies - Packet Filtering – IDS

**SUGGESTED ACTIVITIES :**
- EL – Digital Signature
- Consider that you are owning an insurance company, list the preparations and procedure to issue digital certificate for your customers.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VI: NETWORK SECURITY**

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Cryptography and Network Security - Symmetric Key Encipherment - Asymmetric Key- Encipherment - Integrity, Authentication, and Key Management

**SUGGESTED ACTIVITIES :**
- Exemplify a scenario where symmetric key algorithms / asymmetric key algorithms is more suitable
- EL – Key Management

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VII: AUTHENTICATION**

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**SUGGESTED ACTIVITIES:**
- EL - Biometrics
- Many websites require users to register before they can access information or services. Suppose that you register at such a website, but when you return later you’ve forgotten your password. The website then asks you to enter your email address, which you do. Later, you receive your original password via email. Discuss several security concerns with this approach to dealing with forgotten passwords.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

<table>
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<tr>
<th>MODULE VIII: AUTHORIZATION</th>
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**SUGGESTED ACTIVITIES:**
- EL - Design and implement your own visual CAPTCHA. Outline possible attacks on your CAPTCHA. How secure is your CAPTCHA?
- EL - Design and implement your own audio CAPTCHA. Outline possible attacks on your CAPTCHA. How secure is your CAPTCHA?

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

<table>
<thead>
<tr>
<th>MODULE IX: CERTIFICATION, ACCREDITATION, AND SECURITY ASSESSMENTS</th>
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**SUGGESTED ACTIVITIES:**
- Consider that you are assigning a duty of chief information security officer (CISO) to one of your employee. Define the roles and responsibilities of the CISO and his/her team
- EL - security polices for an organization

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

<table>
<thead>
<tr>
<th>MODULE X: Real world Security Protocols</th>
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**SUGGESTED ACTIVITIES :**
- EL - WEP

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes
TEXT BOOK

REFERENCES:

COURSE OUTCOMES
Upon completion of the course, the students will be able to:
- Explain software security development life cycle, list of attacks in Network, Host and Information and write the consequences of the attack
- Analyze risks in a given activity and write the impact of risk.
- Differentiate security models and suggest best model for the given institution
- Differentiate the functions of IDS and Firewall
- Explain the features of digital certificate
- Document security polices and management activities for an organization.

EVALUATION PATTERN:

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CS6008 CRYPTOGRAPHY AND NETWORK SECURITY

Prerequisites for the course: Computer Networks

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</table>
OBJECTIVES:
- To know the various art of the security exploitation
- To learn secure programming techniques
- To understand the mathematics behind cryptography
- To know the standard algorithms used to provide confidentiality, integrity and authenticity
- To learn the public key infrastructure that will be used for security practices

<table>
<thead>
<tr>
<th>MODULE I: FUNDAMENTALS</th>
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<tbody>
<tr>
<td>Syllabus Review - Memory Management Basics - Review of Assembly - Recognizing C and C++ Code Constructs in Assembly - Using GDB to reverse engineer code</td>
<td></td>
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</tbody>
</table>

SUGGESTED ACTIVITIES:
- Flipped Classroom
- EL - Finding passwords in executables using GDB

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quiz on Memory Management - understanding where different memory is allocated in memory

<table>
<thead>
<tr>
<th>MODULE II: MEMORY CORRUPTION</th>
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<tbody>
<tr>
<td>Buffer Overflows - Understanding system calls in Linux - Shellcode - Global Offset Tables - Format Strings</td>
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</tbody>
</table>

SUGGESTED ACTIVITIES:
- Walk through of syscalls using ltrace and ptrace
- Going through shellshock, heartbleed exploits
- EL - Implementing simple buffer overflows
- EL - Implementing simple format string attacks

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems

<table>
<thead>
<tr>
<th>MODULE III: EXPLOIT TECHNIQUES</th>
<th>L</th>
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<tbody>
<tr>
<td>ELF Executable Format - SQL and SQL Injection - Data Execution Prevention - Return Oriented Programming</td>
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SUGGESTED ACTIVITIES:
- EL - Implementing Return Oriented Programming
- EL - Implement SQL injection in PHP based websites

SUGGESTED EVALUATION METHODS:
- Assignment - Exploit a web server based on PHP to make it print all records, delete all records, drop tables
- Quizzes - Demonstrate understanding of ELF, DEP and ROP

<table>
<thead>
<tr>
<th>MODULE IV: NETWORK EXPLOITS</th>
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</table>

Port Scanning - Fuzzing - ARP Poisoning

**SUGGESTED ACTIVITIES:**
- Using shodan.io for finding protocols in the Internet based on countries
- EL - Using libfuzzer and AFL to fuzz your own C/C++ implementations
- EL - Using arpspoof to poison network and detect using Wireshark

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

### MODULE V : INTRODUCTION TO CRYPTOGRAPHY

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Introduction to Cryptology - Discrete Logarithms - Security Levels - Basics of Number Theory - Fermat and Euler’s Theory

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- Activity - Implementing Simple Caesar Ciphers and breaking it using frequency analysis

**SUGGESTED EVALUATION METHODS:**
- Quizzes

### MODULE VI : NUMBER THEORY

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Euclidian’s Algorithm - Primality Testing – Chinese Reminder Theorem – Finite Fields of the form GF(P)

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- Assignment Problems

### MODULE VII: BLOCK CIPHERS

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Block Ciphers - AES - DES - Block Cipher Modes - Padding

**SUGGESTED ACTIVITIES:**
- EL - Implementing block ciphers using openssl in C/C++.

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### MODULE VIII: HASHES

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Hashing - MD5 - SHA1 - SHA256 - Message Authentication Codes - Hashed Message Authentication Codes – Weaknesses

**SUGGESTED ACTIVITIES:**
- Activity - Demonstrate two different Certificates producing the same MD5 hash http://www.win.tue.nl/~bdeweger/CollidingCertificates/
- EL - Computing MACs, Hashes and HMACs for messages

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
MODULE IX: PUBLIC KEY CRYPTOGRAPHY

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Diffie-Hellman - RSA - Elliptic Curve Cryptography - Digital Signatures – Certificates

SUGGESTED ACTIVITIES:
- Flipped Classroom
- Demonstration - Effectiveness of Elliptic Curves over RSA

SUGGESTED EVALUATION METHODS:
- Assignment problems

MODULE X: PUBLIC KEY INFRASTRUCTURE

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Dream of PKI - PKI Examples - PKI Reality - Key Revocation - PKI Practicalities - Lifetime of Keys

SUGGESTED ACTIVITIES:
- Flipped classroom

SUGGESTED EVALUATION METHODS:
- Security Practices

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

- Present the exploitation present in the security.
- Discuss various types of attacks and their characteristics.
- Illustrate the basic concept of encryption and decryption for secure data transmission.
- Develop solutions for security problems.
- Analyze various cryptography techniques and its applications.

TEXTBOOKS:

REFERENCES:
4. www.shodan.io
5. https://github.com/robertdavidgraham/masscan
7. https://cs.dartmouth.edu/~sergey/cs60/wireshark-exercises.txt
8. https://cs.dartmouth.edu/~sergey/cs60/arp/arp-poisoning.txt
EVALUATION PATTERN

<table>
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<th>Category of Courses</th>
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CS6009 MOBILE NETWORKS
Prerequisites for the course: Computer Networks

OBJECTIVES:
- To provide the fundamentals of the wireless communications systems, the wireless network architectures, protocols, and applications.
- To provide guidelines, design principles and experience in developing applications for small, mobile devices, including an appreciation of context and location aware services.
- To develop an appreciation of interaction modalities with small, mobile devices through the implementation of simple applications and use cases.
- To introduce wireless communication and networking principles, that support connectivity to cellular networks, wireless internet and sensor devices.
- To understand the use of transaction and e-commerce principles over such devices to support mobile business concepts.
- To appreciate the social and ethical issues of mobile computing, including privacy.

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<th>MOBILE NETWORKS</th>
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MODULE I:
Introduction – Applications – Signals – Signal Propagation (including effects)– Multiplexing (SDM, FDM, TDM, CDM) – Spread spectrum (FHSS, DSSS)

SUGGESTED ACTIVITIES:
- Analyze the problem definition and select a suitable multiplexing strategy.
- Case study on Multi propagation effects
- Debate on mobile applications – Need, Quality of living.
- Depict the evolvement in the techniques using timelines

**SUGGESTED EVALUATION METHODS:**
- Tutorial/ Assignments
- Quiz

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<th>MODULE II</th>
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**SUGGESTED ACTIVITIES:**
- Target evaluation – given a solution attempt to check for correctness.
- Given a scenario, identify and debate on the suitability in multiple access schemes.
- Practical – Devise an orthogonal code and simulate the data transfer across end points using CDMA.
- Survey on any two MAC algorithms used in wireless networks

**SUGGESTED EVALUATION METHODS:**
- Report writing – How efficiency enhances on usage of the TDMA scheme in a real time application.
- Effect of combined TDMA, FDMA in terms of measuring parameters like cost, transmitter power etc.
- Focus groups

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<tbody>
<tr>
<td>IEEE 802.11 - System Architecture and Protocol Architecture of IEEE 802.11 (Infrastructure based WLAN and Ad-hoc Networks) – Physical and MAC layer (Distributed Coordinated Function, Point Coordinated Function with various variants of CSMA CA) – MAC management (Synchronization, Power Management and Roaming in both types of WLAN)</td>
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**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- Simulate the multiple access of the channel by the various mobile stations using all CSMA CA variants
- Debate on the modifications required for Ad-hoc networks in comparison with infrastructure-based WLAN.

**SUGGESTED EVALUATION METHODS:**
- Quiz
- Written Evaluation

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**SUGGESTED ACTIVITIES:**
- Flipped classroom
- Comparison across the various standards.
- Selection of appropriate standards for a problem description

**SUGGESTED EVALUATION METHODS:**
- Target evaluation – Checking the appropriate selection of standards
- Convincing the selection of the standard by stating reasons.

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GSM – DECT – UMTS

**SUGGESTED ACTIVITIES:**
- Understanding the elements, its function and signals of GSM required to establish a call
- Need of different techniques for sending voice and data.

**SUGGESTED EVALUATION METHODS:**
- Written Assignment – Components in respective systems
- Question generation

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Mobile AD HOC Networks - AD HOC Routing Protocols – DSDV - DSR and AODV Routing Techniques - Quality of service in Mobile Ad hoc Networks

**SUGGESTED ACTIVITIES:**
- Practical - Implementation Routing protocols and discuss the efficiency
- Flipped Classroom
- Application wide QoS requirements

**SUGGESTED EVALUATION METHODS:**
- Assignments
- Quiz

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Mobile Internet Protocol - IP Packet Delivery - Tunneling and Encapsulation - Reverse Tunneling – DHCP

**SUGGESTED ACTIVITIES:**
- Comparison of wired and wireless networks in IP layer
- Learn by analogy – Postal system
- Simulate the working of DHCP

**SUGGESTED EVALUATION METHODS:**
- Learn by visualization – Preparing placards, Storyboarding
- Problem sets to understand the encapsulation

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**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- Internet search – to understand the need of Security

**SUGGESTED EVALUATION METHODS:**
- Assignment
- Learn by visualization – Preparing placards, Storyboarding

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Traditional TCP – TCP improvements for mobile devices

**SUGGESTED ACTIVITIES:**
- Debate – Will traditional TCP work for wireless?
- Internet Search – Compare the available TCP methods for mobility
SUGGESTED EVALUATION METHODS:
- Assignment
- Quiz
- Flipped Classroom

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History of mobile application frameworks, Application models of mobile application frameworks, Challenges in Developing Mobile Apps (Resource constraints, security, mobility), Context Aware Computing, Service Discovery Middleware, Protocols (Auto configuration, Energy efficient communication, Mobility requirements)

SUGGESTED ACTIVITIES :
- Review of Mobile Applications
- Special additions to mobile applications

SUGGESTED EVALUATION METHODS:
- Mini Project – context aware mobile solutions
- Devising algorithms for service discovery
- Develop energy efficient mobile applications

TEXT BOOKS:

REFERENCES:

EVALUATION PATTERN

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COURSE OUTCOMES:
Upon Completion of the course, the students will be able to:
- Develop the concept of systems thinking in the context of mobile and wireless systems
- Develop knowledge of the interplay of concepts and multiple sub-disciplines in mobile and wireless systems
- Develop knowledge and experience in mobile interface and applications design, and development techniques and methodologies set in the context of a research project addressing a real-world application
- Apply various computation methods and algorithms as a part of mobile application development
- Evaluate mobile computing applications, computation methods and algorithms through experiments and simulations

**CO-PO Mapping**

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**CS6010 WIRELESS AND SENSOR NETWORKS**

**Prerequisites for the course:** Computer Networks

**OBJECTIVES:**
- To learn the fundamental technologies that help in the networking of wireless devices.
- To learn about different wireless technologies.
- To understand about sensor networks and the challenges involved in managing a sensor network.
- To study the various protocols at various layers and its differences with traditional protocols.
- To evaluate the performance of sensor networks and identify bottlenecks.

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**MODULE I INTRODUCTION**

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**SUGGESTED ACTIVITIES:**
- Survey on various wireless technologies

**SUGGESTED EVALUATION METHODS:**
- Quizzes
- Assignment

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**SUGGESTED ACTIVITIES:**
- Survey on various wireless technologies

**SUGGESTED EVALUATION METHODS:**
- Quizzes
- Assignment

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**SUGGESTED ACTIVITIES:**
- Assign papers to read and present in class.

**SUGGESTED EVALUATION METHODS:**
- Evaluation of the presentation

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**SUGGESTED ACTIVITIES:**
- Comparison of different wireless technologies

**SUGGESTED EVALUATION METHODS:**
- Assignments

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<th>OVERVIEW OF WIRELESS SENSOR NETWORKS</th>
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<td>Characteristics of Wireless Sensor Networks - Challenges for WSN - mobile ad-hoc vs sensor networks – Sensor node Architecture - Physical layer and transceiver design considerations in WSNs.</td>
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**SUGGESTED ACTIVITIES:**
- Understanding of commercial sensor products

**SUGGESTED EVALUATION METHODS:**
- Class presentations and discussions

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<th>MODULE VI</th>
<th>MAC LAYER FOR WSN</th>
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**SUGGESTED ACTIVITIES:**
- Survey on various MAC protocols

**SUGGESTED EVALUATION METHODS:**
- Class presentations and discussions

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<tr>
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</table>
geographic routing- mobile nodes-Data centric and content-based networking-Data aggregation.

**SUGGESTED ACTIVITIES:**
- Study of latest network simulation tools

**SUGGESTED EVALUATION METHODS:**
- Basic network demonstrations.

### MODULE VIII LOCALIZATION

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**SUGGESTED ACTIVITIES:**
- Study on WSN data gathering methods and tools

**SUGGESTED EVALUATION METHODS:**
- Demo

### MODULE IX DATA AGGREGATION

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**SUGGESTED ACTIVITIES**
- Study on various localization and data aggregation techniques

**SUGGESTED EVALUATION METHODS:**
- Group Discussions

### MODULE X IoT AND WSN

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**SUGGESTED ACTIVITIES:**
- Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot-Techniques for Protocol Programming.
- Explore to the latest applications of commercial sensors.

**SUGGESTED EVALUATION METHODS:**
- Simple application using anyone of the commercial sensor node

**TEXT BOOKS:**

**REFERENCES:**
2. Pei Zheng, Feng Zhao, David Tipper, Jinmei Tatuya, Keiichi Shima, Yi Qian, larry L. Peterson, Lionel M. Ni, Manjunath D, Qing Li, Joy Kuri, Anurag Kumar, Prashant

EVALUATION PATTERN:

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OUTCOMES:
Upon completion of the course, the students will be able to
- Design MAC and Routing protocols for wireless and sensor network
- Prototype sensor networks using commercial components
- Apply knowledge of wireless sensor networks (WSN) to various application areas.
- Formulate and solve problems creatively in the areas of WSN and IoT
- Evaluate the performance of sensor networks and identify bottlenecks.

CO-PO Mapping

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CS6011 GPU COMPUTING

Prerequisites for the course:
Programming with C, Computer Architecture

OBJECTIVES:
- To acquire a basic knowledge of GPU
- To understand the programming for heterogeneous architectures
- To know programming for massively parallel processors
To understand the issues in mapping algorithms for GPUs

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MODULE I:
Understanding Parallelism with GPU - CUDA Hardware Overview, Threads, Blocks, Grids, Warps, Scheduling

SUGGESTED ACTIVITIES:
- Compare and Contrast Multicore and GPUs
- Scheduling given problem with its input size into blocks and grids
- Experimenting different block sizes

SUGGESTED EVALUATION METHODS:
- Assignment on GPU Applications
- Evaluation of simple problems with no data parallelism using GPU
- Evaluation of the ability to map a data parallel problem into GPU processor space

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Memory Handling with CUDA: Shared memory, Global memory, Constant memory, Texture memory

SUGGESTED ACTIVITIES:
- Exploring different memory types
- Finding optimal memory based on data size and reuse
- Using textures for Graphics

SUGGESTED EVALUATION METHODS:
- Assignment on data representation on different memories
- Evaluation of programs that manages data among different blocks and different memories
- Evaluation of data transfers in between host and device using programs

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CUDA - Multi GPU - Multi GPU Solutions

SUGGESTED ACTIVITIES:
- Mapping large problem into GPU and executing
- Handling synchronization across different GPUs

SUGGESTED EVALUATION METHODS:
- Evaluating different ways to partition problems for different SMs and different GPUs
- Assignment on data distribution among different GPUs
- Assignment on handling larger problem space into different GPUs

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Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource contentions, Self-tuning Applications

SUGGESTED ACTIVITIES:
- Problem decomposition
- Memory selection for different data sizes
- Pinned memory usage
- Zero copy memory usage

SUGGESTED EVALUATION METHODS:
- Identify the resource requirement for the given problem and input size

Attested
- Quiz on Memory, Data transfer, Threads and optimization

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Common problems - CUDA error handling

**SUGGESTED ACTIVITIES:**
- Dealing with memory allocation errors
- Dealing with memory transfer errors
- Dealing with pitched memory

**SUGGESTED EVALUATION METHODS:**
- Assignment on pitched memory allocation
- Evaluating programs that process multi-dimensional arrays using pitched memory

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Parallel programming issues, Synchronization, Algorithmic Issues, Finding and avoiding errors

**SUGGESTED ACTIVITIES:**
- Synchronization of threads within thread blocks
- Synchronization threads among thread blocks
- Explicit synchronization

**SUGGESTED EVALUATION METHODS:**
- Evaluation of handling programs with data parallelism and dependence across neighbors
- Assignment on synchronization and errors

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Parallel Patterns : Convolution, Prefix Sum

**SUGGESTED ACTIVITIES:**
- Computing prefix sum
- Sparse matrix computations

**SUGGESTED EVALUATION METHODS:**
- Programming assignment for Computing prefix sum
- Programming assignment for Convolution

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Parallel Patterns : Sparse matrix - Matrix Multiplication

**SUGGESTED ACTIVITIES:**
- Computing prefix sum
- Sparse matrix computations

**SUGGESTED EVALUATION METHODS:**
- Programming assignment for Computing matrix addition
- Programming assignment for Computing matrix multiplication using shared memory

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Programming heterogeneous cluster - CUDA Dynamic Parallelism

**SUGGESTED ACTIVITIES:**
- Experimenting different GPUs
- Creating cluster of GPUs for problem solving
- Experimenting recursive algorithms

**SUGGESTED EVALUATION METHODS:**
- Programming assignment on graph traversal

Attested
• Programming assignment on tree traversal
• Programming assignment on binary search

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Introducing OpenCL, OpenACC, Thrust.

SUGGESTED ACTIVITIES:
• Application development using OpenCL
• Application development using OpenACC
• Application development using Thrust

SUGGESTED EVALUATION METHODS:
• Programming assignment for rendering
• Programming assignment for stencils
• Programming assignment for sort, scan scatter skeletons

TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to
• Write programs for CUDA architecture
• Implement algorithms in GPUs to get maximum occupancy and throughput
• Program in any heterogeneous programming model
• Create a cluster of GPU’s

EVALUATION PATTERN

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166
Prerequisites for the course: None

OBJECTIVES:

- To learn the architecture and programming of ARM processor
- To learn the architecture and programming of 8051 Microcontroller
- To familiarize with the embedded computing platform design and analysis
- To get exposed to the basic concepts of real time operating systems
- To design an embedded processor based system for a real-time application.

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**MODULE I:**

**SUGGESTED ACTIVITIES:**
- EL – Study of ARM Simulator Software, Mapping of Embedded Design Process to a simple Embedded Application
- Flipped Classroom
- Practical - ARM basic instruction set

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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CPUs – Programming Input and Output - Supervisor Mode, Exceptions, Traps – Co-processors – Memory System Mechanisms

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL – Study of applications using ARM processor
- Practical - combination of C and assembly language programming for interrupt handling, serial communication

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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CPU Bus – Memory Devices – I/O devices – Component Interfacing - Embedded Software Development Tools – Emulators and Debuggers

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL – Study of applications using ARM processor interfacing
- Practical - combination of C and assembly language programming for applications using memory, I/O interface, real-time clock and simple digital LED interface
- EL – Study of EDK Toolkit, Emulators and Debuggers
- Flipped Classroom
- Practical – Implement a Simple Embedded Application in any EDK toolkit

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE IV:

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8051 Microcontroller – Architecture – Assembly Language Programming –Instruction Set — Addressing Modes - Input/output Port, Timers and Serial Port – Interrupt Handling

**SUGGESTED ACTIVITIES :**
- Flipped classroom
- EL – Study of Keil 8051 Microcontroller Development tool, Introduction to Embedded C
- Practical – Implementation of Software development using Keil compiler, 8051 assembly programming, Data transfer and Branch instructions, Arithmetic and Logical instructions
- C Flipped Classroom
- EL – Programming in Embedded C
- Practical - Implementation of 8051 timers/ counters, serial port and Interrupts programming in assembly and Embedded

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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8051 Microcontroller - IO Interfacing – Memory Mechanisms – Memory Interfacing - Processes and Operating Systems–Preemptive Real-Time Operating Systems - Priority Based Scheduling

**SUGGESTED ACTIVITIES :**
- Flipped Classroom
- EL- 8051 Interfacing like LED seven segment, keyboard interfacing
- Practical – Implementation of 8051 Interfacing - ADC, Stepper Motor in assembly and Embedded C
- Discussion of various RTOs
- Flipped Classroom for further study
- EL – Comparison of the different RTOs
- Practical – Implementation of Real Time Scheduling of Tasks

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Inter-Process Communication Mechanisms– basic functions – System Level, Task, mailbox and
Queue related Functions

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- EL – study of functions related scheduling and inter-process communications with respect to any specific RTOs
- Practical – Implementation of Inter-task communications- Semaphores, Events, mailboxes, pipes in any RTOs

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Design Methodologies – Complete Design of Example Embedded Systems

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- EL – Apply the design methodology to the chosen application
- Practical – Mini project Implementation – an Embedded Application Development on any EDK

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Project demonstration and presentation
- Quizzes
- Tutorial problems
- Project design methods
- Project demo
- Mini project design and implementation

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Program Design – Assembly, linking and loading – Basic Compilation Techniques - Program Optimization

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- EL – study of the working of assemblers and linkers for Embedded Systems
- Practical – Compilation, assembly and linking of the Mini Project

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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System and Program Level – Performance and Power - Analysis and Optimisation – Program Validation and Testing

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- EL – Study of the Embedded Testing tools
- Practical – Program validation and testing and performance analysis for the Mini project Implementation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Multiprocessors in Embedded Systems – CPUs and Accelerators – System Architecture Framework - Networks for Embedded Systems

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- EL – Study of practical applications using multiprocessors

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**TEXTBOOKS:**

**REFERENCES:**

**OUTCOMES:**
Upon completion of the course, the students will be able to:
- Describe the architecture and programming of ARM processor and Microcontroller.
- Outline the concepts of embedded systems.
- Explain the basic concepts of real time Operating system design.
- Use the system design techniques to develop software for embedded systems.
- Differentiate between the general purpose operating system and the real time operating System.
- Model real-time applications using embedded-system concepts.

**EVALUATION PATTERN:**

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CS6013 UNIX INTERNALS

Prerequisites for the course: Operating Systems

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OBJECTIVES
1. To learn the fundamentals and design principles of the UNIX operating system.
2. To learn the design of the internal algorithms of the UNIX operating system.
3. To know and understand the data structures used in the implementation of the UNIX operating system.
4. To understand the implementation of various system calls of the UNIX operating system.
5. To understand the use and working of the shell

MODULE I:
General Overview: History - System structure - User perspective - Operating system services - Assumptions about hardware. Introduction to kernel: Architecture of UNIX operating system - Introduction to system concepts

SUGGESTED ACTIVITIES:
- Explore UNIX commands
- Assignment on processor support for kernel/user mode and interrupts/exceptions

SUGGESTED EVALUATION METHODS:
- Quizzes for UNIX Commands
- Assignments

MODULE II:
The Buffer Cache - Buffer headers – Structure of the Buffer Pool – Scenarios for Retrieval of a Buffer–Reading and Writing Disk Blocks – Advantages and Disadvantages of the Buffer Cache

SUGGESTED ACTIVITIES:
- EL- Implementation of buffer free list and hash queue
SUGGESTED EVALUATION METHODS:
- Assignment

MODULE III:

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Internal Representation of Files: Inodes – Structure of a Regular File – Directories – Conversion of a Path Name to an Inode – Super Block – Inode Assignment to a New File – Allocation of Disk Blocks

SUGGESTED ACTIVITIES:
- EL - Use stat command, system call to get inode information
- EL - Implementation of linked list of free disk blocks
- Flipped classroom for ‘Allocation of Disk Blocks’

SUGGESTED EVALUATION METHODS:
- Quizzes

MODULE IV:

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SUGGESTED ACTIVITIES:
- EL - Use system calls creat, open, read, write, lseek, dup in programs
- EL - Programs using pipes, use mount/umount commands

SUGGESTED EVALUATION METHODS:
- Assignments
- Quizzes

MODULE V:

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Process States and Transitions – Layout of System Memory – The Context of a Process

SUGGESTED ACTIVITIES:
- EL- View process layout using readelf, /proc/mem

SUGGESTED EVALUATION METHODS:
- Assignments
- Quizzes

MODULE VI:

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Manipulation of the Process Address Space

SUGGESTED ACTIVITIES:
- Flipped classroom for free region, detach region

SUGGESTED EVALUATION METHODS:
- Assignments
- Quizzes

MODULE VII:

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SUGGESTED ACTIVITIES:
- EL - Use fork, exec, kill, signal, brk
- Flipped classroom for 'wait' system call

**SUGGESTED EVALUATION METHODS:**
- Assignments
- Quizzes

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Shell – System Boot and the INIT Process– Process Scheduling

**SUGGESTED ACTIVITIES :**
- EL- implementation of a basic shell
- Assignment on system boot in other Linux distributions (rc, upstart)

**SUGGESTED EVALUATION METHODS:**
- Assignments
- Quizzes

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Swapping – Demand Paging

**SUGGESTED ACTIVITIES :**
- Tutorial on working sets

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems

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Inter process communication - Messages - Shared memory - Semaphores

**SUGGESTED ACTIVITIES :**
- EL – Programs for messaging, shared memory, semaphores

**SUGGESTED EVALUATION METHODS:**
- Assignment
- Quizzes

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

- Design and implement the subsystems of the kernel
- Understand the implementation of Unix-like operating systems
- Create and rebuild the system calls of an open source operating system
- Create and modify the data structures of Unix-like operating systems
- Optimize open source operating systems by creating/modifying the internal files and scripts

**TEXT BOOK:**
REFERENCES:

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CS6014 IOT AND SMART APPLIANCES

Prerequisites for the course: None

OBJECTIVES:
- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for smart applications

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Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

SUGGESTED ACTIVITIES:
- EL: Do a survey of different real-world IoT applications
- EL : Survey the open hardware platforms available for IoT and compare their characteristics

SUGGESTED EVALUATION METHODS:
- Check survey for breadth and depth – pairwise comparison
- Quiz
MODULE II : Things in IoT

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Sensors, Actuators and Smart Objects – IoT Hardware platforms – Arduino/Raspberry Pi

SUGGESTED ACTIVITIES:
- Assignment on operational principles of sensors and actuators
- Miniproject on building a smart system – Identify the sensors required for the system, connect sensors (such as temperature, pressure, light) to a suitable IoT hardware platform and take measurements

SUGGESTED EVALUATION METHODS:
- Quiz on sensors and actuators
- Demonstration of practical setup on connecting sensors

MODULE III : IoT connectivity Technologies

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Connecting Smart Objects - IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 1901.2a, 802.11ah and LoRaWAN

SUGGESTED ACTIVITIES:
- Assignment on access technologies – (Use simulator)
- Flipped classroom for 802.11
- EL : Alternatives to LoRaWAN
- Miniproject on building a smart system – Choose appropriate access technology and connect the hardware to the Internet

SUGGESTED EVALUATION METHODS:
- Quiz on access technologies
- Quiz on LoRaWAN
- Demonstration of practical setup on connecting to the internet

MODULE IV : Network Layer

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Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo-Routing over Low Power and Lossy Networks (RPL)

SUGGESTED ACTIVITIES:
- Find the RFCs related to Layer 2 and layer 3 IoT protocols

SUGGESTED EVALUATION METHODS:
- Quiz

MODULE V : Transport Layer

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Application Transport Methods: Application Layer Not Present, Supervisory Control and Data Acquisition (SCADA)

SUGGESTED ACTIVITIES:
- Assignment on RPL – (simulator could be used)
- Flipped classroom

SUGGESTED EVALUATION METHODS:
- Quiz
- Demonstration of practical setup

**MODULE VI: Application Layer and Cloud Services**

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Application Layer Protocols: CoAP and MQTT – Service discovery – mDNS - Cloud and Fog
Topologies – Cloud services model – Fog Computing

**SUGGESTED ACTIVITIES:**
- Miniproject on building a smart system – Choose appropriate application protocol and connect to the cloud using available open platforms (such as IBM Bluemix)
- Use a simulator such as Fogsim to study the characteristics of fog computing

**SUGGESTED EVALUATION METHODS:**
- Quiz
- Cloud SIM and Fogsim Demonstration

**MODULE VII: Data Analytics for IoT**

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Data analytics: Structured Vs Unstructured data and Data in Motion Vs Data in Rest – Role of machine learning – No SQL databases

**SUGGESTED ACTIVITIES:**
- Miniproject on building a smart system – Choose appropriate analytics mechanisms to analyze the data collected, and build the application

**SUGGESTED EVALUATION METHODS:**
- Demo of project

**MODULE VIII: Bigdata Analytics tool and IoT Security**

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Frameworks: Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics –

**SUGGESTED ACTIVITIES:**
- EL : Explore data analytics on any open/academic license framework

**SUGGESTED EVALUATION METHODS:**
- Quiz

**MODULE IX: IoT Security**

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Security in IoT - Cisco IoT system - IBM Watson IoT platform

**SUGGESTED ACTIVITIES:**
EL : Review of security in various IoT platforms

**SUGGESTED EVALUATION METHODS:**
Quiz

**MODULE X: Applications in IoT**

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Smart appliances and applications: Autonomous cars – Connected cars – Smart Home appliances –
Smart speakers – Smart energy.

SUGGESTED ACTIVITIES:
- Design the architecture and use cases for various smart systems – (eg., agriculture, home automation, smart campus, smart hostel)
- Mini-project on building a smart system – Enhance the system with additional smart features

SUGGESTED EVALUATION METHODS:
- Report and Presentation of architecture solutions
- Demonstration of complete smart system

TEXTBOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
1. Explain the concept and architecture of IoT.
2. Choose the right sensors and actuators for an application.
3. Analyze various protocols for IoT.
4. Apply data analytics and use cloud/fog offerings related to IoT.
5. Analyze applications of IoT in real-time scenario
6. Design an IoT based smart system using open hardware platforms and open cloud offerings.

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CS6015 MULTI CORE ARCHITECTURES

Prerequisites for the course: Computer Architecture

OBJECTIVES:
- To introduce the students to the recent trends in the field of Computer Architecture and identify performance related parameters
- To learn to exploit ILP using various techniques
- To study about the various types of multiprocessor systems and their challenges
- To understand the various types of optimizations performed in a hierarchical memory system
- To explore the exploitation of data level parallelism, thread level parallelism and request level parallelism in different types of computer systems
- To understand the need for domain specific architectures and learn their characteristics

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MODULE I:

SUGGESTED ACTIVITIES:
- EL - Review of the fundamental concepts of Computer Architecture
  - Study of Existing Multicore architecture Simulator

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

MODULE II:
### Module III

**Instruction-Level Parallelism - Basic Compiler Techniques for Exposing ILP**
- Reducing Branch Costs with Advanced Branch Prediction
- Overcoming Data Hazards with Dynamic Scheduling
- Dynamic Scheduling Algorithm

**Suggested Activities:**
- Flipped classroom and activity
- EL – Dynamic scheduling - Loop based example
  - Simulation of ILP exploitation on simulator – Experiment with timing model for a 5-stage single-issue processor pipeline

**Suggested Evaluation Methods:**
- Assignment problems
- Quizzes
- Report of work done on simulator

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### Module IV

**Multiprocessors**
- Classes - Issues
- Centralized Shared-Memory Architectures
- Cache Coherence
- Snooping Coherence Protocols
- Limitations
- Performance of Symmetric Shared-Memory Multiprocessors
- Distributed Shared-Memory Architectures
- Directory-Based Coherence

**Suggested Activities:**
- Flipped Class room
- EL - Simulation of the concepts for ILP exploitation

**Suggested Evaluation Methods:**
- Assignment problems
- Quizzes
- Report of work done on simulator

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### Module V

**Synchronization Issues**
- Basic Hardware Primitives
- Implementing Locks using Coherence
- Introduction to Models of Memory Consistency
- Interconnection Networks

**Suggested Activities:**
- Flipped Class room
- EL - In a standalone framework (shell provided by instructor) or simulator, implement directory or snoopy coherence protocol.

**Suggested Evaluation Methods:**
- Assignment problems
- Quizzes
- Evaluation of EL

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- EL – Write and run benchmarks on the simulator to demonstrate synchronization issues and solutions

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
- Report on EL

**MODULE VI:**

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Memory Hierarchy Design - Cache Memory - Performance Issues - Advanced Optimizations of Cache Performance - Memory Technology and Optimizations - Protection Aspects of Virtual Memory and Virtual Machines

**SUGGESTED ACTIVITIES :**
- EL - Model cache optimization – eg. a lockup-free data cache in C/C++ (support miss-under-misses, hit-under-misses)
- Flipped Classroom

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
- Report on EL

**MODULE VII:**

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Exploiting Data-level Parallelism - Vector Architectures - Vector Execution Time - Vector Instructions - Optimizations in Vector Architectures - SIMD Instruction Set Extensions for Multimedia, Detecting and Enhancing Loop-Level Parallelism

**SUGGESTED ACTIVITIES :**
- Combinations of in Class & Flipped class rooms
- EL – Project : Implement an idea from a research paper (to be given/approved by the instructor) and attempt to reproduce the paper's results on a standard simulator

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE VIII:**

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Graphics Processing Units - Salient Features - Example Architectures - GPU Computational Structures - Comparison with Vector Architectures

**SUGGESTED ACTIVITIES :**
- Flipped classroom
- EL – continue on project implementation

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes
MODULE IX:

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**SUGGESTED ACTIVITIES:**
- EL - Case Study of a Typical WSC

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Project demonstration and presentation

MODULE X:

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Domain Specific Architectures - Introduction - Guidelines for DSA - Example DSAs like Google’s TPU, Intel Crest, Microsoft Catapult and Pixel Visual Core.

**SUGGESTED ACTIVITIES:**
Combination of in class & Flipped
Survey of Intel/AMD/ARM processors – categorize and classify

**SUGGESTED EVALUATION METHODS:**
- Quizzes
- Project demonstration and presentation

OUTCOMES:

Upon completion of the course, the students will be able to:
- Demonstrate how ILP is exploited with static and dynamic approaches
- Discuss the different types of multiple issue processors and instruction scheduling
- Critically examine the various cache coherence protocols
- Discuss the support provided by the architecture for providing synchronization
- Point out optimization techniques for improving the performance of the memory hierarchy design
- Critically analyse the characteristics of the various types of multicore architectures and how they exploit different types of parallelism

TEXT BOOKS:
2. Recent papers as applicable from the internet for case studies.

REFERENCE BOOKS:
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CS6016

GRAPHICS AND MULTIMEDIA

Prerequisites: None

Objectives:
- To Understand and apply the 2D viewing pipeline
- To learn the 3D Object representations and the 3D viewing pipeline
- Focus on advanced Graphics for visual realism, with add on exposure to OpenGL programming.
- Introduce Multimedia elements, file formats, data structures, data compression
- To learn authoring multimedia content.

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MODULE I:

Computer Graphics terminology – Hardware – Software APIs – Coordinate Systems

SUGGESTED ACTIVITIES:
- In Class activity – simple exercises on display device configuration
- Graphics cards, display devices, Installation of APIs
- EL – Graphics cards, display devices, APIs

SUGGESTED EVALUATION METHODS:
- Assignments
- Quizzes

MODULE II: 2D Graphics

2D Transformations – Viewing - Clipping

SUGGESTED ACTIVITIES:
- Flipped classroom and activity
- Solving exercise problems on Transformations, clipping
- performing transformations on 2D shapes, clipping
- EL – 2D Transformations, Viewing, clipping

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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Mesh Modeling, splines, coordinate systems

**SUGGESTED ACTIVITIES :**
- Using software like 3D Studio Max / Unity or equivalent for understanding coordinate systems
- EL – Splines, Understanding Mesh modeling for standard objects – cube, sphere

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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3D Transformations, Viewing – Projections

**SUGGESTED ACTIVITIES :**
- Simple classroom exercises on 3D Transformations, Projections
- Implementation of 3D transformations on 3D objects
- EL – Implementation of 3D transformations on 3D objects, Quaternions, Projections

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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Color Models, Visible Surface Detection

**SUGGESTED ACTIVITIES :**
- Simple exercise problems on VSD
- removing Hidden surfaces
- EL – Hidden surface removal, Shaders, Rendering

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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Shading, Textures, Ray Tracing.

**SUGGESTED ACTIVITIES :**
- Applying shading, shadows, textures, Rendering.
- EL – Shaders, shadows, textures, Rendering

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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Definitions – Applications – Elements – File formats - Animation Techniques

**SUGGESTED ACTIVITIES :**
- Implementing simple animations using any 2D or 3D software tools
- EL- simple animations, file formats

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE VIII: Multimedia data compression**
- Data Compression (Text, Audio, Image, Video), Multimedia Data Structures

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**SUGGESTED ACTIVITIES:**
- Exercise problems on Text compression, Image compression
- EL-Latest compression standards and formats, Text Compression, Image compression, 2D Animation using software like Flash or equivalent.

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE IX: Multimedia Authoring**

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**SUGGESTED ACTIVITIES:**
- Creating Interactive multimedia presentations using Authoring tools / software,
- EL – Latest authoring tools / frameworks, Creating Interactive multimedia presentations using Authoring tools / software, Creating Animations in 2D and 3D

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE X: Applications of Multimedia**

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**SUGGESTED ACTIVITIES:**
- Flipped classroom
- Creating simple games, Virtual Reality, Web authoring
- EL- Designing presentations, Creating simple games, interactive simulations, learning, Virtual Reality, Web authoring

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**Outcomes:**
Upon completion of the course, the students will be able to:
- Implement 2D transformations and viewing algorithms
- Solve problems in 3D transformations and viewing
- Demonstrate visual realism by adding textures, lights shadows etc using tools/software
- Critically examine file formats, compression of media elements
• Author multimedia presentations using 2D and 3D authoring tools in addition to advanced VR and AR applications

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CS6017  HUMAN COMPUTER INTERACTION
Pre-requisites: None
OBJECTIVES:
• To determine the necessity of user interaction by understanding usability engineering and user modeling
• To learn the methodologies for designing interactive systems
- To investigate the core and complex design issues for interaction
- To examine the evaluation methodologies of design
- To understand design issues for web and mobile platforms

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**MODULE I : INTRODUCTION**
- Context of Interaction – Ergonomics - Designing Interactive systems – Understanding Users-cognition and cognitive frame works, User Centre approaches

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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**MODULE II : USABILITY**
- Usability, Universal Usability, Understanding and conceptualizing interaction, Guidelines, Principles and Theories

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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**MODULE III : INTERACTION DESIGN - 1**
- Universal design principles, guidelines, heuristics, HCI patterns, design frame works, design methods, prototyping

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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**MODULE IV : INTERACTION DESIGN - 2**
- Understanding interaction styles, Direct Navigation and Immersive environments, Fluid navigation, Expressive Human and Command Languages, Communication and Collaboration

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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**MODULE V : DESIGN ISSUES**
- Advancing the user experience, Timely user Experience, Information search, Data Visualization

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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**MODULE VI: EVALUATION**
- Evaluation Techniques- assessing user experience- usability testing – Heuristic evaluation and walkthroughs, analytics predictive models.

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
• Quizzes

MODULE VII: MODELS AND THEORIES - 1

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Cognitive models, Socio-organizational issues and stake holder requirements, Communication and collaboration models

SUGGESTED EVALUATION METHODS:
• Assignment problems
• Quizzes

MODULE VIII: MODELS AND THEORIES - 2

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Task analysis, dialog notations and design, Models of the system, Modeling rich interaction, Ubiquitous computing

SUGGESTED EVALUATION METHODS:
• Assignment problems
• Quizzes

MODULE IX: DESIGNING INTERACTION FOR THE WEB

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Hypertext, Multimedia and WWW, Designing for the web Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Use Transitions-Lookup patterns-Feedback patterns

SUGGESTED EVALUATION METHODS:
• Assignment problems
• Project demonstration and presentation

MODULE X: DESIGNING INTERACTION FOR THE MOBILE

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Mobile apps, Mobile navigation, content and control idioms, Multi-touch gestures, Inter-app integration, Mobile web.

SUGGESTED EVALUATION METHODS:
• Assignment problems
• Quizzes

TEXT BOOKS:

REFERENCES:
OUTCOMES:
Upon completion of the course, the students will be able to:
- Understand the basics of human computer interactions via usability engineering and cognitive modeling.
- Understand the basic design paradigms, complex interaction styles.
- Understand the fundamental design issues.
- Examine the evaluation of interaction designs and implementations.
- Understand the models and theories for user interaction
- Elaborate the above issues for web and mobile applications.

Evaluation Pattern:

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CO-PO Mapping

CS6018  IMAGE PROCESSING
Pre-requisites: None

OBJECTIVES:
- To learn about the basic concepts of digital image processing and various image transforms.
- To familiarize the student with the image enhancement techniques
- To expose the student to a broad range of image processing techniques and their applications.
- To appreciate the use of current technologies those are specific to image processing systems.
- To expose the students to real-world applications of image processing.

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MODULE I : FUNDAMENTALS OF IMAGE PROCESSING

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SUGGESTED ACTIVITIES:
- Introduction in class
- EL – Applications of Image Processing

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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Pixel connectivity – Distance measures - Color fundamentals and models - File Formats, Image operations.

SUGGESTED ACTIVITIES:
- Flipped classroom
- EL – Image operations

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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SUGGESTED ACTIVITIES:
- flipped classroom
- EL – Image enhancement in the frequency domain

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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SUGGESTED ACTIVITIES:
- flipped classroom
- Analysis in class
- EL – Image Restoration algorithms

SUGGESTED EVALUATION METHODS:
- Quizzes

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Multi Resolution analysis: Image pyramids - Multi resolution expansion - Wavelet transforms

SUGGESTED ACTIVITIES:
- Introduction in class

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes
- EL – Wavelet Transforms

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**SUGGESTED ACTIVITIES:**
- Introduction in class
- Analysis in Class
- Flipped Classroom
- EL – Lossy Compression standards

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE VII: IMAGE SEGMENTATION**

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Image Segmentation - Detection of discontinuities - Edge operators - Edge linking and boundary detection - Thresholding - Region based segmentation

**SUGGESTED ACTIVITIES:**
- Flipped class room
- EL – Region Based Segmentation

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE VIII: FEATURE EXTRACTION**

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Image Features and Extraction – Image Features – Types of Features – Feature extraction - Texture - Feature reduction algorithms – PCA – Feature Description.

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL – Feature extraction and engineering

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

**MODULE IX: IMAGE CLASSIFICATION**

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Image classifiers – Bayesian Classification, nearest neighborhood algorithms - Support Vector Machines - Image Clustering Algorithms – Hierarchical and Partitional clustering algorithms.

**SUGGESTED ACTIVITIES:**
- Flipped class room
- EL - SVM

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Project demonstration and presentation

**MODULE X: APPLICATIONS OF IMAGE PROCESSING**

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**SUGGESTED ACTIVITIES:**
- Applications in class
- EL - Mini project for designing and implementing a digital image processing system

**SUGGESTED EVALUATION METHODS:**
- Quizzes
Outcomes:

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

- Implement basic image processing algorithms.
- Design an application that uses different concepts of Image Processing.
- Apply and develop new techniques in the areas of image enhancement - restoration - segmentation - compression - wavelet processing and image morphology.
- Critically analyze different approaches to different modules of Image Processing.
- Build and use any simple Image Classifier using standard approaches

Evaluation Pattern:

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Text Books:

Reference Books:

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CS6019 AUGMENTED REALITY AND VIRTUAL REALITY

Prerequisites: None
### Objectives:
- To understand Virtual Reality
- To Familiarize with hardware and software for AR and VR
- To understand Augmented Reality
- To develop Augmented Virtuality
- To develop Mixed Reality applications

### Augmented Reality and Virtual Reality Table

<table>
<thead>
<tr>
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### Module I: Introduction
Fundamental Concepts and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality

**Suggested Activities:**
- EL - Knowing the head mounted display optics and unity tool.

**Suggested Evaluation Methods:**
- Assignment problems
- Quizzes

### Module II: Multiple Modals of Input and Output Interface in Virtual Reality
Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual / Auditory / Haptic Devices

**Suggested Activities:**
- EL – Interfaces and Device types

**Suggested Evaluation Methods:**
- Assignment problems
- Quizzes

### Module III: Environment Modeling in Virtual Reality
Geometric Modeling; Behavior Simulation; Physically Based Simulation

**Suggested Activities:**
- EL - Generating graphical models

**Suggested Evaluation Methods:**
- Assignment problems
- Quizzes

### Module IV: Haptic & Force Interaction in Virtual Reality -1
Concept of haptic interaction; Principles of touch feedback and force feedback;

**Suggested Activities:**
- EL - Adding physical components

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192
### SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

<table>
<thead>
<tr>
<th>MODULE V: Haptic &amp; Force Interaction in Virtual Reality -2</th>
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<th>SUGGESTED ACTIVITIES:</th>
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<td>• EL – Adding Haptics using Arduino VR</td>
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<td>• EL – Annotation authoring AR, navigation</td>
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<td>• EL – Modeling AR using ARCore, ARKit, Vuforia, etc - Simple Game</td>
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SUGGESTED EVALUATION METHODS:
- Assignment problems
- Project demonstration and presentation

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Outcomes:
Upon completion of the course, the students will be able to:
- Point out the various user interaction modes
- Design and Create user environment
- Demonstrate VR through simple applications
- Familiarity with Augmented Reality and Mixed Reality Development platforms
- Use techniques to combine AR and VR to generate Augmented Virtuality
- Implement simple mixed reality applications

Text Books:

Reference Books:

Web References:
1. https://nptel.ac.in/courses/106106138/
2. https://www.evl.uic.edu/aej/491/

Laboratory Requirements:
- **Hardware**: VR/AR headset, Mobile Phones, ArduinoVR and Tablets
- PC based - Oculus Rift, HTC Vive, HoloLens, Windows Mixed Reality Ultra
- PC – GPU with I7 PROCESSOR,
- Smart Gloves, Intel RealSense Depth Camera, Kinect

- **Software (VR)**: Three.js, Unity3D, Blender, Vuforia
- **Software (AR)**: A-Frame, ARToolKit, ARKit, Wikitude, Vupohoria, ARCore, AR.js

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CS6020 DIGITAL SIGNAL PROCESSING

Prerequisites for the course: None

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OBJECTIVES:
- To understand the concepts involved in designing analog and digital filters.
- To learn the design of infinite and finite impulse response filters for filtering undesired signals.
- To acquire knowledge on the various errors encountered in a DSP system.
• To understand signal processing concepts in systems having multiple sampling rate.
• To gain knowledge about adaptive filters.

### MODULE I:

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**SUGGESTED ACTIVITIES:**
- EL– Classifying signals and systems
- In Class activity – Problems on Response and Correlation.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE II:

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Review of Z-transform, Fourier Transform – Fast Fourier transform– FFT applications – Overlap add and overlap save methods

**SUGGESTED ACTIVITIES:**
- In Class activity – Problems based on FFT, overlap add, overlap save methods.
- EL – Circular and linear convolution review

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE III:

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Analog filters –Butterworth filters, Chebyshev Type I filters

**SUGGESTED ACTIVITIES:**
- EL – Visualizing signals of practical day to day activities like traffic light, count of vehicles, temperature of the day, stock market changes
- Tutorial – Analog filter design using Butterworth and Chebyshev approximation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

### MODULE IV:

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Transformation of prototype LPF to BPF /BSF/ HPF – Transformation of analog filters to digital using Impulse invariance method and bilinear transformation

**SUGGESTED ACTIVITIES:**
- EL – Flipped Class-room – Approximation of derivatives and its mathematical representation
- In-class activity – Derivation of Impulse invariance method and bilinear transformation

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE V:**

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IIR Filter Structures – Realization - Direct Forms – Cascade and Parallel Realization

**SUGGESTED ACTIVITIES:**
- EL – Lattice structures - Flipped Class room
- Tutorial on filter structures

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VI:**

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Linear phase FIR filter design – Fourier Series method - Window method – Rectangular, Hamming, Hanning windows

**SUGGESTED ACTIVITIES:**
- EL – Proof that FIR filters conserve phase
- EL – Other windows like Bartlett, triangular windows for FIL filter design
- Mini project

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VII:**

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FIR Filter design – frequency sampling method – Structures of IIR systems – Transversal and linear phase structures – IIR & FIR comparison

**SUGGESTED ACTIVITIES:**
- EL – Flipped class room – Comparison of FIR and IIR and applications
- Mini project topic review

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

**MODULE VIII:**

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Representation of numbers-ADC Quantization noise-Coefficient Quantization error, Product Quantization error

**SUGGESTED ACTIVITIES:**
- EL – Circular integral computation
- Mini project review
SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX:

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Truncation & rounding errors - Limit cycle due to product round-off error – Round-off noise power

SUGGESTED ACTIVITIES:
- EL – Noise power derivation
- Mini project review / demo

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

MODULE X:

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Multi-rate signal processing – Decimation, Interpolation, Fractional decimation – Properties of Decimator and Interpolator

SUGGESTED ACTIVITIES:
- EL – application of Multi-rate signal processing
- EL – Flipped class room Noble identities and their application
- Mini project demo

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Tutorial problems
- Mini project evaluation

MODULE XI:

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Adaptive filters – Echo Cancellation – Channel Equalization

SUGGESTED ACTIVITIES:
- EL – Other areas of adaptive filter applications
- Mini project demo

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Quizzes
- Mini project evaluation

TEXT BOOKS:

REFERENCES:

OUTCOMES:

Upon completion of the course, the students will be able to:
- Analyze and apply appropriate frequency transformations for any class of signal
- Analyse and design filters for a given signal processing application
- Identify and compute the errors encountered in a digital signal processing systems
- Design applications that involves signal and image processing by adopting appropriate transformation and filtering techniques
- Justify and apply possible extensions to digital filters for a given application

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CO-PO Mapping

CS6021 SOFTWARE TESTING AND QUALITY ASSURANCE

Prerequisites for the course: Software Engineering

OBJECTIVES:
- To understand the basics of software quality
- To learn and apply the metrics related to software quality
- To emphasize the importance of testing in SDLC
- To differentiate the test case view for functional and structural testing
- To gain insight into automation

CS6021 SOFTWARE TESTING AND QUALITY

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Software Quality – Errors, Faults and Failure – Software Quality Factors – Development Plan and Quality Plan

### SUGGESTED ACTIVITIES:
- Flipped Classroom on Software Project Lifecycle
- External Learning on Designing the Software Development Plan and Software Quality Plan for Sample Application

### SUGGESTED EVALUATION METHODS:
- Assignments on Software Project Lifecycle for sample application

## MODULE II

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### SUGGESTED ACTIVITIES:
- External Learning on Comparison of Review Methodologies
- External Learning on developing Software Review Documentation for Sample Application

### SUGGESTED EVALUATION METHODS:
- Assignment: Preparing SCM document for sample application

## MODULE III

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### SUGGESTED ACTIVITIES:
- Flipped Classroom: Assessing Software Quality for Sample application using Software Size Metrics

### SUGGESTED EVALUATION METHODS:
- Assignment problems on calculation of software quality metrics for sample application

## MODULE IV

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Object Oriented Metrics: coupling, cohesion, inheritance and size metrics – Test Metrics: Time, Quality of Source Code, Source Code Coverage, Test case defect density, Review Efficiency

### SUGGESTED ACTIVITIES:
- Flipped Classroom: Assessing OO Software Metrics for sample application

### SUGGESTED EVALUATION METHODS:
- Assignment on assessing software test metrics for sample application

## MODULE V

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Testing Lifecycle – Defect Life Cycle - Defect Management: Defect Reporting & Classification – Taxonomy of Bugs

### SUGGESTED ACTIVITIES:
- Flipped Classroom on Bug Reporting for any Bug related to Sample Application

**SUGGESTED EVALUATION METHODS:**
- Quiz on Open Source tools on Bug Tracking

**MODULE VI**

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SDLC – Levels of Testing- Functional Testing – Structural Testing

**SUGGESTED ACTIVITIES :**
- Flipped Classroom on Comparison of SDLC from various perspectives

**SUGGESTED EVALUATION METHODS:**
- Quiz on Open source Tools for Unit Testing

**MODULE VII**

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Test Automation Frameworks – Types – Types of Automation Tools

**SUGGESTED ACTIVITIES :**
- Flipped Classroom: Testing the Sample Application using Robotium

**SUGGESTED EVALUATION METHODS:**
- Assignments: Testing the Sample Application using JUnit

**MODULE VIII**

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Test Management: Test planning, Cost Benefit Analysis, Test Organization, Monitoring & Control

**SUGGESTED ACTIVITIES :**
- Assignments on Test Planning for Sample Application

**SUGGESTED EVALUATION METHODS:**
- Assignments on Cost Benefit Analysis for Sample Application

**MODULE IX**

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Creating Test Cases from Requirements and Use Cases – Selection, minimization and prioritization of test cases for Regression Testing

**SUGGESTED ACTIVITIES :**
- Assignment on High Level Use Cases, Detailed Use Cases and Use case Scenarios for Sample Application

**SUGGESTED EVALUATION METHODS:**
- Assignment on generating Test Cases from Use Cases for Sample Application

**MODULE X**

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Object oriented Testing – Testing Web Applications

**SUGGESTED ACTIVITIES :**
- Flipped Classroom: Testing a sample web application
- Tutorial: Security Testing of Web Application

**SUGGESTED EVALUATION METHODS:**
- Assignment: Designing test cases for a sample web application using form based testing
- Quiz on Security Testing of Web Application

**TEXT BOOKS:**

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Create and Analyze software documentation for SDLC phases
- Assess software quality using Software Quality Metrics
- Differentiate between Functional and Structural Testing practices
- Test a given application using Automated Testing Tools
- Develop test cases to remove bugs

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CS6022 SOFTWARE PROJECT MANAGEMENT

Prerequisites for the course: Software Engineering

OBJECTIVES:
- To understand the fundamental principle of software project management
- To be familiar with the different methods & techniques used for project management
- To learn project activity sequencing and scheduling
- To learn to evaluate risks and estimate cost of the project
- To study the impact of risks on project schedules

CS6022 SOFTWARE PROJECT MANAGEMENT

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Activities covered by Software Project Management - Overview of stepwise project planning

**SUGGESTED ACTIVITIES:**
- External Learning: Creating products related to stepwise project planning for the sample project application

**SUGGESTED EVALUATION METHODS:**
- Assignments: Identifying different activity / stages for a sample project application

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**SUGGESTED ACTIVITIES:**
- External Learning: Identify major risks & rank them in order of importance for the sample project application

**SUGGESTED EVALUATION METHODS:**
- Assignment: Cost-Benefit analysis on sample project application

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Effort Estimation: Problems with over and under estimation, Software effort estimation techniques

**SUGGESTED ACTIVITIES:**
- External Learning: Metrics for Effort Estimation

**SUGGESTED EVALUATION METHODS:**
- Assignment: Identify tasks/activities and respective effort estimates in duration (weeks) for the sample project application

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Albrecht Function Point Analysis, Function Points Mark II, Object Points, COCOMO model

**SUGGESTED ACTIVITIES:**
- External Learning: For the sample project application, identify each instances of each external user type

**SUGGESTED EVALUATION METHODS:**
- Assignment: Classify the complexity of Sample Application and use them to calculate Function Points

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Activity Planning: Projects and activities, Sequencing and Scheduling activities, Network Planning Models

**SUGGESTED ACTIVITIES:**
- External Learning: Draw a project schedule chart by considering the nature of software development process and the available resources ordered in sequence

**SUGGESTED EVALUATION METHODS:**
- Assignment: Draw an activity network using CPM or precedence network conventions for the sample project application

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Risk Management: Nature of risks, Managing risks, Risk identification, Risk Analysis, Reducing Risks, Evaluating risks to schedule

**SUGGESTED ACTIVITIES:**
- External Learning: For the sample project application, identify hazards and analyse the risk exposure
SUGGESTED EVALUATION METHODS:
- Assignment: Using PERT evaluate the effects of uncertainty including expected duration of activity and standard deviation for the sample project application

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Monitoring and control: creating the framework, collecting the data, visualizing progress

SUGGESTED ACTIVITIES:
- External Learning: For the identified activities, describe project monitoring using visualization approaches, for the sample application.

SUGGESTED EVALUATION METHODS:
- Assignment: Project Monitoring Visualization for sample application

MODULE VIII:
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Monitoring and control: cost monitoring, earned value analysis

SUGGESTED ACTIVITIES:
- External Learning: Tools for budgeting

SUGGESTED EVALUATION METHODS:
- Assignment: Project Monitoring Visualization for sample application

MODULE IX:
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Managing people and organizing team: understanding behavior, organizational behavior, selecting the right person, motivation, working in groups, becoming a team, decision making, leadership

SUGGESTED ACTIVITIES:
- External Learning: Forming the right team and Work Delegation

SUGGESTED EVALUATION METHODS:
- Assignment: Deciding the qualities of team member for sample application

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Seven core project metrics, quality indicators, pragmatic software metrics, metrics automation

SUGGESTED ACTIVITIES:
- External Learning: Automation tools for obtaining relevant software project metrics

SUGGESTED EVALUATION METHODS:
- Assignment: Assessing the software metrics for the sample application

TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Perform stepwise project planning
- Perform cost-benefit analysis and cash-flow forecasting techniques
- Apply function point analysis
- Model project scheduling using CPM or precedence networks
- Perform risk analysis and risk reduction

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**CS6023 SOFTWARE TEST AUTOMATION**

**Prerequisites for the course:** Software Engineering

**OBJECTIVES:**
- To gain insight into test automation
- To learn tools for web testing
- To learn web driver scripting
- To handle exceptions in test automation
- To understand the procedure of automating software tests

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**MODULE I :**

Automation lifecycle and Automation goals - Test Automation Frameworks – Types – Types of Automation Tools

**SUGGESTED ACTIVITIES :**
- External Learning on Test Automation Tools like JMeter
- Tutorial: Installation of Selenium and Selenium IDE

**SUGGESTED EVALUATION METHODS:**
- Quiz on JMeter

**MODULE II :**

Selenium IDE – Selenium versions and their capabilities - Selenium Test scripting – Cucumber Behavior Driven Development

**SUGGESTED ACTIVITIES :**
- External Learning on using Cucumber
- In-class Activity: Installation of Java, Eclipse, Cucumber
SUGGESTED EVALUATION METHODS:
- Assignment: Quiz on Using Cucumber

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SUGGESTED ACTIVITIES:
- External Learning on open-source test automation projects from GitHub
- External Learning on using WebDriver with various browsers like Firefox, IE, Chrome, Safari and Opera

SUGGESTED EVALUATION METHODS:
- Assignments: Demo and Programming Assignments on Actions of Web Elements
- Assignments: Using Selenium Web Driver for a sample project

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Functional web testing: using Twill, using Selenium - Testing simple web applications with Twill and Selenium

SUGGESTED ACTIVITIES:
- External Learning on Twill installation
- External Learning on testing a web application using Twill

SUGGESTED EVALUATION METHODS:
- Assignment: Testing a web application using Selenium

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Selenium web driver based test automation frameworks – selenium WebDriver scripting

SUGGESTED ACTIVITIES:
- Assignments on Data-driven Tests using Excel files with Selenium WebDriver
- External Learning on capturing screenshots using Selenium WebDriver

SUGGESTED EVALUATION METHODS:
- Quiz on Selenium WebDriver Scripting

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Test NG scripting – Test Automation Results Management – Selenium Exceptions Guide

SUGGESTED ACTIVITIES:
- External Learning on installation and using TestNG
- Assignments on handling selenium exceptions

SUGGESTED EVALUATION METHODS:
- Quiz on Working with Selenium Exceptions

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Selenium Grid - Selenium IDE

SUGGESTED ACTIVITIES:
- External Learning on Performance Testing Basics

SUGGESTED EVALUATION METHODS:
- Quiz on Working with Selenium Grid

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Selenium IDE scripting – Advanced Selenium IDE

SUGGESTED ACTIVITIES:
SUGGESTED EVALUATION METHODS:
- Quiz on Selenium IDE Scripting

MODULE XI:

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SUGGESTED ACTIVITIES:
- External Learning: Automating CRM Applications using Selenium POM

SUGGESTED EVALUATION METHODS:
- Quiz and Programming Assignments on Selenium POM

MODULE X:

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SUGGESTED ACTIVITIES:
- External Learning on automating iOS and Android tests using Appium

SUGGESTED EVALUATION METHODS:
- Quiz on App Development using Selenium

TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Conduct automated software testing
- Test a web application using Selenium
- Test a web application using Twill
- Understand selenium POM
- Learn testing iOS and Android applications

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CS6024 TEST DRIVEN DEVELOPMENT

Prerequisites for the course: Software Engineering

OBJECTIVES:
- To get insight into test driven development
- To learn to use tools for unit testing in TDD
- To identify potential regions for refactoring in a software application
- To understand pattern based TDD
- To gather ideas on TDD tools and frameworks

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CS6024 TEST DRIVEN DEVELOPMENT

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MODULE I

Test Driven Development: Basics, Techniques in TDD, Importance of Test cases

SUGGESTED ACTIVITIES:
- External Learning on Agile & TDD
- External Learning on Building a Test Case in Java

SUGGESTED EVALUATION METHODS:
- Assignment: Importing a suitable sample application in Java from GitHub

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The Money Example – xUnit - Refactoring by Example

SUGGESTED ACTIVITIES:
- External Learning on working with JUnit

SUGGESTED EVALUATION METHODS:
- Assignments Programming Problems on Refactoring

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Principles of Refactoring – Bad smells in code – Building tests – catalog of refactoring

SUGGESTED ACTIVITIES:
- Flipped Classroom on finding bad smells in code for sample application

SUGGESTED EVALUATION METHODS:
- Assignments Programming Problems on Refactoring

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Composing methods - moving features between objects – organizing data – simplifying conditional expressions – making method calls simpler – dealing with generalization

SUGGESTED ACTIVITIES:
- Assignments: Programming Problems on Generalisation for sample application

SUGGESTED EVALUATION METHODS:
- Quiz on Simplifying Method Calls

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Big refactoring – refactoring, reuse and reality – refactoring tools

SUGGESTED ACTIVITIES:
- External Learning on refactoring tools

SUGGESTED EVALUATION METHODS:
- Assignments: Finding potential locations for Big Refactoring for sample application

MODULE VI

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Patterns for TDD: TDD patterns – Red Bar patterns, testing patterns, green bar patterns

SUGGESTED ACTIVITIES:
- External Learning on TDD patterns

SUGGESTED EVALUATION METHODS:
- Assignment: Using Red-green TDD patterns in sample application

MODULE VII

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Patterns for TDD: TDD patterns –xUnit Patterns, Design Patterns

SUGGESTED ACTIVITIES:
- External Learning on GoF patterns and their usage in TDD

SUGGESTED EVALUATION METHODS:
- Quiz on Abstract Factory Pattern in TDD

MODULE VIII

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TDD Tools, Frameworks and Environments: Virtual Machines, IDE, Unit Testing Frameworks

SUGGESTED ACTIVITIES:
- External Learning on Open Source TDD Unit Testing tools – JUnit, HtmlUnit

SUGGESTED EVALUATION METHODS:
- Quiz on JUnit, HtmlUnit

MODULE IX

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TDD Tools, Frameworks and Environments: Hamcrest and AssertJ, Code coverage tools, Mocking frameworks

SUGGESTED ACTIVITIES:
- External Learning on Open Source TDD code coverage tools – CodeCover, Coverage.py

SUGGESTED EVALUATION METHODS:
- Quiz on CodeCover, Coverage.py

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TDD Tools, Frameworks and Environments: User-Interface testing, Behavior-driven development
SUGGESTED ACTIVITIES:
- Flipped Classroom: UI testing for sample application

SUGGESTED EVALUATION METHODS:
- Quiz on Open Source tools on Behavior Driven Development (BDD) - Cucumber

TEXT BOOKS:

REFERENCE BOOKS:

OUTCOMES:
Upon completion of the course, the students will be able to:
- To learn working with JUnit
- To identify bad smells in code
- To understand and apply refactoring tools
- To apply Red-green TDD patterns
- To learn to use various code-coverage tools

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CS6025  SUPPLY CHAIN MANAGEMENT

Prerequisites for the course: Software Engineering

OBJECTIVES:
- To understand the role and value of Customers and Stakeholders in a Business Enterprise
- To provide better Quality-of-Service to Customer using state-of-art Supply Chain Practices
• To interpret global Supply Chain Practices and the significance of logistics
• To identify best storage model suitable for Supply Chain Applications
• To create, protect and grow long term environmental, social and economic value for all stakeholders involved in bringing products and services to market.

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**MODULE I**

Foundations of Supply Chain Management - Defining Supply Chain Management – Drivers of Supply Chain Change - Five SCM Tasks

**SUGGESTED ACTIVITIES:**
• External Learning: Exploring Supply Chain Management and Supply chain Drivers for Sample Application

**SUGGESTED EVALUATION METHODS:**
• Assignment on Supply Chain Drivers for Sample Application

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**SUGGESTED ACTIVITIES:**
• External Learning: Studying Sample Application for SCM standards

**SUGGESTED EVALUATION METHODS:**
• Quiz on Supply Chain Project Management & Process Standards

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SCM Maturity Models – Executing SCM Processes - Developing a Supply Chain Strategy

**SUGGESTED ACTIVITIES:**
• External Learning: Studying Sample Application for Supply Chain Strategy

**SUGGESTED EVALUATION METHODS:**
• Quiz on Supply Chain Maturity Models
• Quiz on Supply Chain Strategy

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**SUGGESTED ACTIVITIES:**
• External Learning: Studying Value Addition Aspects of Logistics for Sample Application

**SUGGESTED EVALUATION METHODS:**
• Quiz on Value Addition in Logistics

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211
& Materials Management

SUGGESTED ACTIVITIES:
- External Learning: Choosing the cost-effective Supply Chain Segments for Sample Application

SUGGESTED EVALUATION METHODS:
- Quiz on Configuration management for reduction of Supply Chain Costs

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Procurement and inventory decisions: Basic inventory planning & Management – Inventory & supply chain – Purchasing & supply

SUGGESTED ACTIVITIES:
- External Learning: Demand forecasting for Sample Application
- External Learning: Alternate Inventory and Procurement strategies

SUGGESTED EVALUATION METHODS:
- Quiz on Procurement Logistics Management
- Quiz on Distribution Logistics Management

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SUGGESTED ACTIVITIES:
- External Learning: Designing Innovative Storage Systems

SUGGESTED EVALUATION METHODS:
- Quiz on Global Storage Systems

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SUGGESTED ACTIVITIES:
- External Learning: Logistics for Sample Application

SUGGESTED EVALUATION METHODS:
- Quiz on Logistics and Distribution

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SUGGESTED ACTIVITIES:
- External Learning: Transportation in Value Chains

SUGGESTED EVALUATION METHODS:
- Assignment on Eco-friendly Logistics
- Quiz on Supply Chain Operations Management

TEXT BOOKS:
REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- To develop comprehensive strategic and tactical plans for an organization.
- Integrate appropriate technologies in developing dynamic solutions to business opportunities and challenges.
- Correlate the key responsibilities and interrelationships of all stakeholders in an organization’s supply chain.
- Apply and use analytical techniques for logistics management
- Identify storage, maintenance and handling systems across various modes of logistics

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CS6026 GAME DEVELOPMENT

Pre-requisites: None

OBJECTIVES:
- To realize the importance of 3D Graphics for game design
- To familiarize with the process of game design
- To learn the processes, mechanics, issues in game design
- To understand the architecture of game engines and gaming platforms
- To develop simple interactive games

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Coordinate systems, 3D Graphics, Modeling, Curves and Surfaces

SUGGESTED ACTIVITIES:
- Flipped Classroom
- EL – Basics of 3D Graphics

SUGGESTED EVALUATION METHODS:
- Assignment problems
- Quizzes

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213
## MODULE II: 3D GRAPHICS FOR GAME DEVELOPMENT

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Vertex Processing, Rasterization, Fragment Processing, Output merging, Image Texturing

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL - Rasterization

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

## MODULE III: 3D GRAPHICS FOR GAME DEVELOPMENT

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Illumination and shaders, Rendering techniques

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL – Shading languages, Applying textures to 3D shapes

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

## MODULE IV: GAME DESIGN PRINCIPLES -1

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Games, Genres, Game worlds, Character Development, storytelling, creating user experience, Game Play

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL – Game terminologies

**SUGGESTED EVALUATION METHODS:**
- Quizzes

## MODULE V: GAME DESIGN PRINCIPLES -2

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Core Mechanics, Game Balancing, Level Design

**SUGGESTED ACTIVITIES:**
- Flipped Classroom
- EL – Game Mechanics design

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

## MODULE VI: GAME DESIGN PRINCIPLES -3

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Collision Detection, Physics based Simulation, Game AI

**SUGGESTED ACTIVITIES:**
- EL – Game AI
- Flipped Classroom

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

## MODULE VII: GAME ENGINE ARCHITECTURE AND ANIMATION
### Game Engine Architecture, scene graphs, sorting, level of detail, Animation

**SUGGESTED ACTIVITIES:**
- Flipped class room
- EL – Animation and rendering techniques

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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Understanding UNITY environment, scripting, sprite animations

**SUGGESTED ACTIVITIES:**
- Flipped classroom
- EL - UNITY

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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More on understanding UNITY for character development, collision detection, physics, level design and fine tuning

**SUGGESTED ACTIVITIES:**
- Flipped class room
- EL – UNITY

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

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<thead>
<tr>
<th>MODULE X:DEMONSTRATION OF GAME PROJECTS</th>
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Implementing and demonstrating Games designed and developed by students using standard tools

**SUGGESTED ACTIVITIES:**
- Flipped class room
- EL - UNITY

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Quizzes

### Outcomes:

Upon completion of the course, the students will be able to:
- Implement simple 3D Graphics applications for Game development
- Use core Game design principles for Game Design
- Analyze Game Engine Architecture and rendering
- Design simple animations
- Use tools like UNITY for Game design and development
Evaluation Pattern:

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Text Books:

Reference Books:
3. https://unity3d.com/

CO-PO mapping:

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CS6027    MODELING AND SIMULATION

Pre-requisites for the course: None

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OBJECTIVES:
- To obtain knowledge and make decisions of any given system.
- To simulate the modeled system for performance study of an actual system.
- To reflect the continuing evolution of simulation software.
- To understand the statistical models in simulation.
- To acquire skills on analysis of simulation data.

MODULE I    INTRODUCTION TO MODELING AND SIMULATION

System modeling - Simulation examples - Types and concepts
### Module II: Modeling Approaches

**Suggested Activities:**
- EL – Single server and multi server exercises

**Suggested Evaluation Methods:**
- Tutorial Problems
- Assignment exercises
- Quizzes

### Module III: Statistical Models in Simulation

**Suggested Activities:**
- EL – Regular sets analysis and model checking

**Suggested Evaluation Methods:**
- Tutorial Problems
- Assignment exercises
- Quizzes

### Module IV: Simulation Software

**Suggested Activities:**
- EL – Poisson process – Empirical distributions

**Suggested Evaluation Methods:**
- Tutorial problems
- Assignment exercises
- Quizzes

### Module V: Queueing Models

**Suggested Activities:**
- EL – Experimental and statistical analysis tools – Trends in simulation software

**Suggested Evaluation Methods:**
- Tutorial problems
- Assignment exercises
- Quizzes
Characteristics of queueing systems – Notations – Long run measures of performance of queueing systems - Markovian models

**SUGGESTED ACTIVITIES:**

- EL – Networks of Queues – Applications of queueing systems

**SUGGESTED EVALUATION METHODS**

- Tutorial problems
- Assignment exercises
- Quizzes

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Random number properties - Generation of pseudo random numbers - Techniques for generating random Numbers

**SUGGESTED ACTIVITIES:**

- EL – Tests for random numbers – Frequency tests – Tests for autocorrelation

**SUGGESTED EVALUATION METHODS**

- Tutorial problems
- Assignment exercises
- Quizzes

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Inverse transform techniques – Exponential distribution – Uniform distribution – Weibull distribution – Triangular distribution

**SUGGESTED ACTIVITIES:**

- EL – Acceptance – Rejection techniques - Direct transformation for the normal and lognormal distributions – Convolution method

**SUGGESTED EVALUATION METHODS**

- Tutorial problems
- Assignment exercises
- Quizzes

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<th>MODULE VIII</th>
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Problem formulation – Input modeling – Verification and validation of simulation models

**SUGGESTED ACTIVITIES:**

- EL – Output analysis for a single model – Comparison of alternative system designs

**SUGGESTED EVALUATION METHODS**

- Tutorial problems
- Assignment exercises
- Quizzes
## MODULE IX  SIMULATION OF MANUFACTURING AND MATERIAL HANDLING SYSTEMS

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- Models of manufacturing systems – Models of material handling - Goals and performance measures – Issues in manufacturing and material handling systems

### SUGGESTED ACTIVITIES:
- EL – Manufacturing examples

### SUGGESTED EVALUATION METHODS
- Tutorial problems
- Assignment exercises
- Quizzes

## MODULE X SIMULATION OF COMPUTER SYSTEMS

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Simulation tools – Model input – High level computer system simulation

### SUGGESTED ACTIVITIES:
- EL – CPU simulation – Memory simulation

### SUGGESTED EVALUATION METHODS
- Tutorial problems
- Assignment exercises
- Quizzes

### TEXT BOOKS

### REFERENCES:

### OUTCOMES:
Upon completion of the course, the students will be able to:
- Model any given system with rationality
- Predict the behavior through fine grained analysis
- Identify the important aspects of discrete event simulation
- Apply the modeling and simulation concepts to manufacturing, services and computing
- Verify and validate simulation models.
Evaluation Pattern:

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CS6028 QUEUING THEORY AND PERFORMANCE EVALUATION OF COMPUTER SYSTEMS

Prerequisites for the course: None

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**OBJECTIVES**

- To learn the foundations for probabilistic analysis
- To learn the queues used in modeling computer systems
- To learn the metrics used to analyze and evaluate computer systems
- To gain better knowledge and understanding of the workloads on computer systems
- To learn the techniques needed to represent data

**MODULE I:**

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**SUGGESTED ACTIVITIES:**

- Explore the different types of random variables, their moments and moment generating functions
- Explore how the operational laws can be used to represent any system
SUGGESTED EVALUATION METHODS:
- Tutorial problems on random variables
- Quizzes

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Performance Bounds: Asymptotic Bounds, Balanced System Bounds.

SUGGESTED ACTIVITIES:
- Assignment on the usage of performance bounds to evaluate computer systems

SUGGESTED EVALUATION METHODS:
- Tutorial problems on random variables
- Quizzes

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Markovian queues – Birth & Death processes – Single and multiple server queueing models – Little’s formula – Queues with finite waiting rooms

SUGGESTED ACTIVITIES:
- Assignment on the application of each queueing model in computer systems

SUGGESTED EVALUATION METHODS:
- Tutorial problems

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Finite source models – Machine Interference Model – Steady State analysis – Self Service Queue.

SUGGESTED ACTIVITIES:
- Assignment on the application of each queuing model in computer systems

SUGGESTED EVALUATION METHODS:
- Tutorial problems

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SUGGESTED ACTIVITIES:
- Assignment on the application of each queueing model in computer systems

SUGGESTED EVALUATION METHODS:
- Tutorial problems

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SUGGESTED ACTIVITIES:
- Explore the usage of different performance metrics
- Assignment on workload

SUGGESTED EVALUATION METHODS:
- Assignments
- Quizzes

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SUGGESTED ACTIVITIES:
- Consider a project which is in progress or is about to be started, and identify suitable techniques to evaluate it and represent the results

SUGGESTED EVALUATION METHODS:
- Assignments
- Quizzes

TEXT BOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to:
- Use and apply the foundations of probabilistic analysis in various applications
- Represent and model the behaviour of any system.
- Analyse and design service processes that use shared resources.
- Apply different types of workload to test a system.
- Precisely represent data.

Evaluation Pattern:

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## CS6029  
### SOCIAL NETWORK ANALYSIS

**Prerequisites for the course:** None

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<td>- To understand the concept of semantic web and related applications</td>
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<td>- To represent knowledge using ontology</td>
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<td>- To understand human behavior insights in social networks</td>
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<td>- To learn about the extraction and mining tools for social networks</td>
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<td>- To visualize social networks</td>
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### MODULE I:

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**SUGGESTED ACTIVITIES:**

- Create a social network with yourself as the central node and minimum of 50 friend nodes using Facebook entries using tools like Protégé / Vizter / Touchgraph
- Calculate the graph parameters

**SUGGESTED EVALUATION METHODS:**

- Tutorial problems
- Assignment problems

### MODULE II:

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<td><strong>Network Measures – Network Models:</strong> Properties of Real-World Networks – Random Graphs – Small-World Model – Preferential Attachment Model</td>
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**SUGGESTED ACTIVITIES:**

- Finding the network related properties such as Degree Distribution, Path length, Centrality of random nodes.

**SUGGESTED EVALUATION METHODS:**

- Tutorial problems
- Assignment problems
**MODULE III**

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web

**SUGGESTED ACTIVITIES:**
- Understand the XML document format for Ontologies

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**MODULE IV**

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language.

**SUGGESTED ACTIVITIES:**
- Creating an ontology using protégé tool
- Creating a sample RDF document for the ontology created
- Checking the validity of the RDF documents using any validator tool

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**MODULE V**

Modelling and aggregating social network data, Ontological representation of social individuals - Ontological representation of social relationships, Aggregating and reasoning with social network data - Advanced representations

**SUGGESTED ACTIVITIES:**
- Create an OWL file which incorporates all the constraints and obtain inferences

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**MODULE VI**


**SUGGESTED ACTIVITIES:**
- Try to detect communities from FOAF Profiles/ Social networking sites
- Mine the community using any one of the community mining algorithm and find patterns

**SUGGESTED EVALUATION METHODS:**
• Tutorial problems
• Assignment problems
• Quizzes

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**SUGGESTED ACTIVITIES:**
- Mine the FOAF network and recommend interests of users to other people in the network
- Predict the behavior of community based on human behavior prediction algorithm

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Predict the behavior of a person from online social networks

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Use tweepy to extract tweets and perform set wise operations

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Project demonstration and presentation

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**SUGGESTED ACTIVITIES:**
- Visualize the social networks using tools like Vizter, Touch graph
- Visualize the bibliography network for coauthorship networks
SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

TEXT BOOKS

REFERENCES:

OUTCOMES: Upon completion of the course, the students will be able to:
- Understand and appreciate the concept of semantic web
- Represent knowledge using ontology
- Design extraction and mining tools for social networks
- Visualize social networks and infer social parameters from the same
- Apply the analytics concept on Online Social networks

Evaluation method to be used:

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Director
Centre for Academic Courses
Anna University, Chennai-600 025
CS6030  NATURAL LANGUAGE PROCESSING

Prerequisites for the course: None

OBJECTIVES:
- To understand basics of linguistics and probability and statistics
- To study concept of morphology, syntax, semantics and pragmatics
- To learn various machine learning techniques used in NLP
- To understand statistical approaches to machine translation
- To understand deep learning for NLP

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MODULE I:
Introduction to Natural Language Processing, Basics of Linguistics and Probability and Statistics

SUGGESTED ACTIVITIES:
- Flipped classroom and activity
- In Class Activity – Linguistic Tagging
- Tutorials – Probability and Statistics for NLP Problems
- Practical – Use of Standard NLP tools for Simple analysis

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Words, Tokenization, Morphology, Finite State Automata, Spelling Correction

SUGGESTED ACTIVITIES:
- In Class Activity - Morphological Tagging
- Tutorial – Finite State Automata – Adjectives
- Assignment Problems – Finite State Automata – Other Grammatical Categories
- Practical- Programming Exercises - Build your Own Morphological Analyzer & Spell Checker

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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Introduction to Statistical NLP - N-grams and Language models - Text classification, Naïve Bayes, Vector space model

Attested
### SUGGESTED ACTIVITIES:
- In Class – Vector Space Model
- Flipped Classroom and Activity
- Project Design

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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<td>Sequence labeling - Part of speech tags, Hidden Markov models</td>
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### SUGGESTED ACTIVITIES:
- Flipped Classroom
- In Class Activity – Part of Speech Tagging
- Tutorial – Hidden Markov Models
- Practical - Implementation of a Simple POS Tagger

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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<td>Syntax Analysis - CYK algorithm, Earley's algorithm, Treebanks and PCFGs</td>
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### SUGGESTED ACTIVITIES:
- Flipped Classroom and Activities
- In Class Activity – Simulation of Earley’s algorithm
- Project Review

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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### SUGGESTED ACTIVITIES:
- In Class Activity – Semantic Exercises
- Use of WordNet
- Flipped Classroom for further study
- Practical - Implementation of Word Sense Ambiguation and Semantic Role labelling

### SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

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<td>Statistical Machine Translation</td>
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SUGGESTED ACTIVITIES:
- In Class Activity – Step by Step Statistical Machine Translation
- Practical - Implementation of one Component of Machine Translation

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Quizzes

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Deep learning for NLP, Word Embedding

SUGGESTED ACTIVITIES:
- In Class Activity – Word Embedding
- Project Submission

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Quizzes
- Project demonstration and presentation

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Information extraction, question answering, Sentiment Analysis

SUGGESTED ACTIVITIES:
- Combination of in class & Flipped Classroom
- Project Submission

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

TEXT BOOKS:

REFERENCE BOOKS:
2. Yoav Goldberg,Graeme Hirst, “Neural Network Methods for Natural Language Processing (Synthesis Lectures on Human Language Technologies)”, Morgan and Claypool Life Sciences, 2017

OUTCOMES:
Upon completion of the course, the students will be able to:
- Understand basics of linguistics and probability and statistics
- Understand morphology, syntax, semantics and pragmatics
- Discuss various machine learning techniques used in NLP
- Understand statistical machine translation
- Understand deep learning for NLP

EVALUATION METHOD:

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CS6031 DATABASE TUNING

Prerequisites for the course: Database Management Systems

OBJECTIVES
- To comprehend the basic principles of database tuning
- To understand the basics of backup and recovery techniques
- To comprehend the principles of query optimization
- To understand the principles of E-commerce application tuning

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Review of Relational databases - Relational Algebra - Transaction Management - Locking and concurrency control - Lock Tuning

**SUGGESTED ACTIVITIES**
- Flipped Class Room
- Study of Concurrency Control technique in any three relational databases

**SUGGESTED EVALUATION METHODS**
- Tutorial Problems
- Assignment Problems
- Quizzes

### MODULE 2

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Structured Query Language - Types of Queries - Procedures - Functions - Triggers

**SUGGESTED ACTIVITIES**
- Flipped Class Room
- Executing different triggers

**SUGGESTED EVALUATION METHODS**
- Tutorial Problems
- Assignment Problems
- Quizzes

### MODULE 3

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Recovery Subsystem – Principles of Backup and Recovery – Tuning the Recovery Subsystem – Operating Systems Considerations – Hardware Tuning

**SUGGESTED ACTIVITIES**
- Flipped Class Room
- NPTEL videos

**SUGGESTED EVALUATION METHODS**
- Tutorial Problems
- Assignment Problems
- Quizzes

### MODULE 4

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B tree – B + Tree – Examples - Hash Structures – Bit Map Indexes – Clustering Indexes – Non Clustering Indexes – Composite Indexes – Hot Tables – Comparison of Indexing and Hashing Techniques.

**SUGGESTED ACTIVITIES**
- Flipped Class Room
- Constructing B Tree B+ tree from given set of data
### SUGGESTED EVALUATION METHODS
- Tutorial Problems
- Assignment Problems
- Quizzes

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- Tuning Relational Systems – Normalization – Denormalization – Clustering Two Tables – Aggregate Maintenance – Record Layout – Query Tuning

### SUGGESTED ACTIVITIES
- Flipped Class Room
- Mooc Classes

### SUGGESTED EVALUATION METHODS
- Tutorial Problems
- Assignment Problems
- Quizzes

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- Client Server Mechanisms – Objects - Application Tools and Performance – Tuning the Application Interface – Bulk Loading Data – Accessing Multiple Databases.

### SUGGESTED ACTIVITIES
- Flipped Class Room
- Exercises on Triggers

### SUGGESTED EVALUATION METHODS
- Tutorial Problems
- Assignment Problems
- Quizzes

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### SUGGESTED ACTIVITIES
- Flipped Class Room
- Mooc Classes

### SUGGESTED EVALUATION METHODS
- Tutorial Problems
- Assignment Problems
- Quizzes

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- Analyzing a Query’s Access Plan – Profiling a Query Execution – DBMS Subsystems – Data Warehousing Tuning.
### SUGGESTED ACTIVITIES
- Flipped Class Room
- Mooc Classes

### SUGGESTED EVALUATION METHODS
- Tutorial Problems
- Assignment Problems
- Quizzes

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Tuning E-Commerce Applications – E-Commerce Architecture – Tuning E-Commerce Architecture -Transaction Chopping

### SUGGESTED ACTIVITIES
- Flipped Class Room
- Mooc Classes
- Casestudy

### SUGGESTED EVALUATION METHODS
- Tutorial Problems
- Assignment Problems
- Quizzes

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### SUGGESTED ACTIVITIES
- Flipped Class Room
- Case study

### SUGGESTED EVALUATION METHODS
- Tutorial Problems
- Assignment Problems
- Quizzes

### TEXT BOOKS

### REFERENCES:
1. Database Systems, C.J. Date Addison Wesley 2004
2. Oracle9i Performance Tuning BPB 2002
OUTCOMES:
Upon completion of the course, the students will be able to
- Point out the significance of database tuning
- Identify suitable backup and recovery techniques
- Optimize queries for tuning databases
- Tune E-Commerce applications
- Point out the significance of time series databases

Evaluation Pattern

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CS6032 SOFTWARE DEFINED NETWORKS

Prerequisites for the course: Computer Networks

OBJECTIVES:
- To learn the basic concepts related to software defined networks.
- To demonstrate knowledge of software defined networking and its principles and applications
- To describe the concepts behind Networks Function Virtualization
- To understand SDN deployment models
- To gain knowledge about the languages and tools used for SDN.

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History and Evolution of Software Defined Networking (SDN): Traditional Switch Architecture - Separation of Control Plane and Data Plane.

SUGGESTED ACTIVITIES:
- Presentation and Discussion on SDN standards

**SUGGESTED EVALUATION METHODS:**
- Quizzes

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OpenFlow protocol Specification - Drawbacks of Open SDN, SDN Via APIs - SDN via Hypervisor-based overlays.

**SUGGESTED ACTIVITIES:**
- Learning Openflow for practical implementation of SDN
- Peer learning for In depth analysis of Openflow protocol components and its architecture

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

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Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework (VMWare and others), Mini Net based examples.

**SUGGESTED ACTIVITIES:**
- Installation of MiniNet
- Mini project or practice problems using MiniNet

**SUGGESTED EVALUATION METHODS:**
- Mini Project Demonstration

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Control Plane: Overview, Existing SDN Controllers including Floodlight and OpenDaylight projects.

**SUGGESTED ACTIVITIES:**
- Comparison of SDN Controllers.
- Group discussion on Floodlight and Opendaylight controller project

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

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Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts.

**SUGGESTED ACTIVITIES:**
- Analysis of firewall implementations
- Case study on SDN switch

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
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Data Plane: Software-based and Hardware-based; Programmable Network Hardware.

**SUGGESTED ACTIVITIES:**
- Activity based Learning on software-based data planes

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

### MODULE VII:

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Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs.

**SUGGESTED ACTIVITIES:**
- Case study of various tools used for SDN deployment
- Programming a SDN for a given task

**SUGGESTED EVALUATION METHODS:**
- Assignment problem
- Quizzes

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Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

**SUGGESTED ACTIVITIES:**
- Peer Learning-Discussion on Network Functions Virtualization
- Implementation of NFV

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

### MODULE IX:

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Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network

**SUGGESTED ACTIVITIES:**
- Peer Learning - Discussion on the need for data centers
- Integration of Topologies and SDN

**SUGGESTED EVALUATION METHODS:**
- Assignment problems

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VLANs – EVPN – VxLAN – NVGRE -Juniper SDN Framework – IETF SDN Framework

**SUGGESTED ACTIVITIES:**
• Activity based learning-Quizzes on SDN Frameworks.

**SUGGESTED EVALUATION METHODS:**
• Assignment problems

**TEXT BOOKS:**

**REFERENCES:**

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

• Understand decoupling of data and control planes in SDN
• Configure an SDN-friendly network emulator
• Program a sample SDN for a given task
• Understand and appreciate network virtualization
• Apply concepts of software defined network principles for the design of new generation of networks.

**Evaluation Pattern:**

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**CS 6033 STORAGE AREA NETWORKS**

Prerequisites for the course: None
Prerequisites for the course: Computer Networks, Computer Architecture and DBMS.

OBJECTIVES:
- To gain proficiency in Storage Area Networks architecture, characteristics and components.
- To make the student acquire sound knowledge of SAN techniques in solving real-time client / server model.
- To familiarize the student with functions and management of SAN.
- To acquaint the need to overcome challenges of SAN using modern technologies.
- To learn Fibre channel protocols and communication of various components in SAN.

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SUGGESTED ACTIVITIES:
- Survey on various storage technologies.

SUGGESTED EVALUATION METHODS:
Class Presentation

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SUGGESTED ACTIVITIES:
- Implement Framing protocols and flow control mechanisms.

SUGGESTED EVALUATION METHODS:
- Discussion.

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SUGGESTED ACTIVITIES:
- Discussion of different SAN topologies.

SUGGESTED EVALUATION METHODS:
- Group discussion.

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SUGGESTED ACTIVITIES:
- Byte encoding Schemes in Fabrics.

SUGGESTED EVALUATION METHODS:
- Assignment
- Quiz

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SUGGESTED ACTIVITIES:
- Characterization of fibre channels and its specification

SUGGESTED EVALUATION METHODS:
- Presentation

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SUGGESTED ACTIVITIES:
- Analyze SCSI bridges and SAN isolation techniques.

SUGGESTED EVALUATION METHODS:
- Assignment.

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SUGGESTED ACTIVITIES:
- Going the Distance with Storage Data

SUGGESTED EVALUATION METHODS:
- Discussion.

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SUGGESTED ACTIVITIES:
- Comparison of Network and Resource management.

SUGGESTED EVALUATION METHODS:
• Assignment.

MODULE IX  L  T  P  EL
Application Studies  2  0  0  3
Application Studies - Video Editing—Backup-Server Clustering- Campus Storage Networks-Disaster Recovery.

SUGGESTED ACTIVITIES:
• Disaster Recovery in an Uncertain World.

SUGGESTED EVALUATION METHODS:
• Discussion.
• Quizzes.

MODULE X  L  T  P  EL
Future of SAN  2  0  0  3
Integration of SAN into Mainstream Networking- Shared Storage- Virtualization – Contributing Technologies.

SUGGESTED ACTIVITIES :
• Contributing Technologies for SAN.

SUGGESTED EVALUATION METHODS:
• Presentation and demo.

TEXT BOOKS:

REFERENCES :

OUTCOMES
Upon completion of the course, the students will be able to

• Understand standards compliance versus interoperability.
• Provide mechanisms for backup/recovery.
• Identify different storage resource management methods.
• Discuss different applications of SAN.
Illustrate the storage infrastructure and management activities

Evaluation pattern

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CS6034    SERVICE ORIENTED ARCHITECTURE

Prerequisites for the course: None

OBJECTIVES:
- To learn the fundamentals of XML to realize a web service
- To learn the basics of web services and its associated features
- To understand the basic principles of service orientation and various WS-* specification standards
- To apply the SOA principles for creating web services
- To analyze the steps involved in designing services using SOA building blocks
- To develop enterprise solutions using advanced concepts such as service composition, orchestration and Choreography

SUGGESTED ACTIVITIES:
- In class activity for authoring XML/JSON document, parsing XML/JSON and using with style sheet

SUGGESTED EVALUATION METHODS:
- Practical Markup languages like MathML, ChemML
- Familiarization with XML authoring and validation tools
- Quizzes
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**SUGGESTED ACTIVITIES :**
- Practical - Understanding RMI, CORBA and DCOM
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures

**SUGGESTED EVALUATION METHODS:**
- Case Study: Inter-Enterprise applications like Insurance Claim processing
- Quizzes

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SOA and service orientation - principles of SOA - service layers - configuration scenarios

**SUGGESTED ACTIVITIES :**
- In Class - Comparing service with object orientation principles
- Service layer identification for specific domain

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Building SOA - Delivery strategies - life cycle phases - service oriented analysis - service modeling

**SUGGESTED ACTIVITIES :**
- In class - Relate business insights and behavioral, legal, and societal expertise in modern information systems and services.
- Practical - Domain specific SOA application analysis

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Building SOA - service oriented design - composition guidelines - service design - business process design

**SUGGESTED ACTIVITIES :**
- In Class - Domain specific SOA design
- Practical - Integration of information systems and development of service-oriented architecture

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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Web Services Basis - Web Services versus SOA - Web services framework, Services (Web

**SUGGESTED ACTIVITIES:**
- In class

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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SOAP Based Web Services - SOAP Protocol - WSDL – UDDI – Web Service Clients and Service Invocation

**SUGGESTED ACTIVITIES:**
- In class activity for identifying web services in specific domains
- Understanding the structure of SOAP, WSDL and UDDI
- Practical knowledge about web services using Apache Tomcat, Axis2 and Derby as well as the Eclipse Development Environment

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems
- Quizzes

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**SUGGESTED ACTIVITIES:**
- Mostly in Class
- Flipped classroom - Analyze different service-oriented computing approaches and open standards.

**SUGGESTED EVALUATION METHODS:**
- Assignment problems
- Project demonstration and presentation

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REST Based Web Services - Principles - Comparison with SOAP - XML Based Web Services – Design and Implementation of REST Services - Resource Oriented Architecture – best practices

**SUGGESTED ACTIVITIES:**
- In class - Compare SOAP with REST WS
- Practical - Create RESTful web services Service which accepts integer ID of the student Service and it should return XML document which represents student and Perform CRUD operations
- EL - Direct to Home Services.

**SUGGESTED EVALUATION METHODS:**
- Tutorial problems
- Assignment problems

SUGGESTED ACTIVITIES:
- In class - Identify and master appropriate software technologies, architectures and systems related to service-oriented computing.
- Case Study - SOA and Web services in J2EE and .Net Platform

SUGGESTED EVALUATION METHODS:
- Tutorial problems
- Assignment problems
- Quizzes

TEXTBOOKS:

REFERENCES:

OUTCOMES:
Upon completion of the course, the students will be able to
- Create basic web services
- Analyze and design SOA based solutions
- Analyze and implement a web service based application
- Discuss the technology underlying service design
- Classify and make reasoned decision about the adoption of different SOA platforms

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244
CS6035 ENTREPRENEURSHIP DEVELOPMENT

Prerequisites for the course: None

OBJECTIVES:
- To learn to create a startup business plan
- To gain an introduction to the key elements of creating an entrepreneurial venture, such as figuring out the market potential and viability, crafting the right business model, determining go-to market strategy, creating a financial model to estimate funding needs, etc.
- To learn the regulatory basics of starting a company in India
- To learn about funding sources and government programs available to support budding entrepreneurs
- To learn the various paths to entrepreneurship by studying real-life entrepreneurial success stories in the Indian context

**CS6035 ENTREPRENEURSHIP DEVELOPMENT**

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**MODULE I:**
Introduction to Entrepreneurship- need -Types of entrepreneurship.

**SUGGESTED ACTIVITIES:**
- Video (Steve Jobs Commencement Address)
- Class discussion on the mind of an entrepreneur and what it takes to be one
- Students asked to form teams and choose startup ideas to develop into a business plan over the course

**SUGGESTED EVALUATION METHODS:**
- Seminar /assignments

**MODULE II:**

**Suggested Activities:**
- "Story of an Entrepreneur" Presentation by student/student-team.

**Suggested Evaluation Methods:**
- Seminar / assignments

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### Module IV: Business Model. Types of Biz Model. Who is the Customer. Why Will They Purchase.

**Suggested Activities:**
- "Story of an Entrepreneur" Presentation by student/student-team

**Suggested Evaluation Methods:**
- Seminar / assignments

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**Suggested Activities:**
- "Story of an Entrepreneur" Presentation by student/student-team

**Suggested Evaluation Methods:**
- Seminar / assignments

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**Suggested Activities:**
- "Story of an Entrepreneur" Presentation by student/student-team
- Project Plan and Financial Model for a sample startup is created in class to demonstrate
### SUGGESTED EVALUATION METHODS:
- Seminar / assignments

### MODULE VII:

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Executive Summary & the 30-second pitch. Fundraising, The fundraising process, Sources of Capital, Incubators. Government programs for Startups

### SUGGESTED ACTIVITIES:
- “Story of an Entrepreneur” Presentation by student/student-team

### SUGGESTED EVALUATION METHODS:
- Seminar / assignments.

### MODULE VIII:

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### SUGGESTED ACTIVITIES:
- “Story of an Entrepreneur” Presentation by student/student-team

### SUGGESTED EVALUATION METHODS:
- Seminar / assignments

### MODULE X:

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- Business Plan case study 2

### SUGGESTED ACTIVITIES:
- Business Plan presentations

### SUGGESTED EVALUATION METHODS:
- Review of presentation

### TEXT BOOKS:

### REFERENCES:
2. Ganesh V, “The Underage CEOs: Fascinating Stories of Young Indians Who Became CEOs in their Twenties”, Collins Business India, 2015. (To be used for “Story of an entrepreneur” presentations.)


OUTCOMES:

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

- Outline the basics of creating a startup in India.
- Discuss the legal and regulatory aspects of starting a business.
- Gain an understanding of the elements of a business.
- Comprehend in more holistic terms, to become industry ready
- Create real business plans that can potentially compete in national level startup competitions and lead to funding.

EVALUATION PATTERN

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