

### Semester V (Third year) Curriculum

#### Branch/Course: Computer Science and Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Engineering Science Course	ESC-EC 501	Signals & Systems	3	0	0	3	100
2	Professional Core Course	PCC-CSE 501	Database Management Systems	3	0	0	3	100
		PCC-CSE 551	Database Management Systems Laboratory	0	0	4	2	100
3	Professional Core Course	PCC-CSE 502	Formal Language & Automata Theory	3	0	0	3	100
4	Professional Core Course	PCC-CSE 503	Object Oriented Programming	2	0	0	2	100
		PCC-CSE 553	Object Oriented Programming Laboratory	0	0	4	2	100
5	Professional Elective Course	PEC-CSE I	Professional Elective-I	3	0	0	3	100
6	Mandatory Course	MC-HU 501	Constitution of India	3	0	0	0	100*
7	Humanities & Social Sciences including Management Course	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
<b>Total:</b>							<b>19</b>	<b>800</b>

PEC-CSE I	
Paper Code	Paper Name
PEC-CSE 511 (a)	Software Engineering
PEC-CSE 511 (b)	Advanced Algorithms
PEC-CSE 511 (c)	Advanced Computer Architecture
PEC-CSE 511 (d)	Real Time Systems

\*Marks for this paper will not reflect in total marks for the semester

## Semester VI (Third year) Curriculum

### Branch/Course: Computer Science and Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Core Course	PCC-CSE 601	Compiler Design	3	0	0	3	100
		PCC-CSE 651	Compiler Design Laboratory	0	0	4	2	100
2	Professional Core Course	PCC-CSE 602	Computer Networks	3	0	0	3	100
		PCC-CSE 652	Computer Networks Laboratory	0	0	4	2	100
2	Professional Core Course	PCC-CSE 653	Python Programming Laboratory	0	0	4	2	100
3	Professional Elective Course	PEC-CSE II	Professional Elective-II	3	0	0	3	100
4	Professional Elective Course	PEC-CSE III	Professional Elective-III	3	0	0	3	100
5	Open Elective Course	OEC-X 621 <sup>#</sup>	Open Elective I	3	0	0	3	100
6	Project	PROJ-CSE 691	Project-I	0	0	6	3	100
7	Humanities & Social Sciences including Management Course	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
<b>Total:</b>							<b>25</b>	<b>1000</b>

PEC-CSE II		PEC-CSE III	
Paper Code	Paper Name	Paper Code	Paper Name
PEC-CSE 611(a)	Artificial Intelligence	PEC-CSE 612(a)	Advanced Operating Systems
PEC-CSE 611(b)	Computer Graphics	PEC-CSE 612(b)	Soft Computing
PEC-CSE 611(c)	Distributed Systems	PEC-CSE 612(c)	Digital Signal Processing
PEC-CSE 611(d)	Embedded Systems	PEC-CSE 612(d)	Data Mining

# Here X denotes the code of the offering departments such as HU/EC/EI/M. Refer to Appendix-I

## Semester VII (Fourth year) Curriculum

### Branch/Course: Computer Science and Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course	PEC-CSE IV	Professional Elective IV	3	0	0	3	100
2	Professional Elective Course	PEC-CSE V	Professional Elective V	3	0	0	3	100
3	Open Elective Course	OEC-X 721 <sup>#</sup>	Open Elective II	3	0	0	3	100
4	Humanities & Social Sciences including Management Course	HSM-HU 702	Values and Ethics	2	0	0	2	100
5	Project	PROJ-CSE 791	Project-II	0	0	12	6	100
6	Project	PROJ-INT 791	Internship	0	0	\$	2	100
<b>Total:</b>							<b>19</b>	<b>600</b>

PEC-CSE IV		PEC-CSE V	
Paper Code	Paper Name	Paper Code	Paper Name
PEC-CSE 711(a)	Computational Geometry	PEC-CSE 712(a)	VLSI System Design
PEC-CSE 711(b)	Multi-agent Intelligent Systems	PEC-CSE 712(b)	Data Analytics
PEC-CSE 711(c)	Image Processing	PEC-CSE 712(c)	Optimization Techniques
PEC-CSE 711(d)	Web and Internet Technology	PEC-CSE 712(d)	Cloud Computing

# Here X denotes the code of the offering departments such as HU/EC/EI/M. Refer to Appendix-I

\$ An Internship of 40 hours per week to be done after 2<sup>nd</sup> / 4<sup>th</sup> / 6<sup>th</sup> semester examination (during semester gap)

### Semester VIII (Fourth year) Curriculum

#### Branch/Course: Computer Science and Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course	PEC-CSE VI	Professional Elective VI	3	0	0	3	100
2	Open Elective Course	OEC-X 821 <sup>#</sup>	Open Elective III	3	0	0	3	100
3	Open Elective Course	OEC-X 822 <sup>#</sup>	Open Elective IV	3	0	0	3	100
4	Project	PROJ-CSE 891	Project-III	0	0	12	6	100
<b>Total:</b>							<b>15</b>	<b>400</b>

PEC-CSE VI	
Paper Code	Paper Name
PEC-CSE 811(a)	Low Power Circuits and Systems
PEC-CSE 811(b)	Internet of Things
PEC-CSE 811(c)	Cyber Security
PEC-CSE 811(d)	Pattern Recognition

# Here X denotes the code of the offering departments such as HU/EC/EI/M/EE/ME. Refer to Appendix-I

# DETAILED SYLLABUS

### Semester V (Third year) Curriculum

#### Branch/Course: Computer Science and Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Engineering Science Course	ESC-EC 501	Signals & Systems	3	0	0	3	100
2	Professional Core Course	PCC-CSE 501	Database Management Systems	3	0	0	3	100
		PCC-CSE 551	Database Management Systems Laboratory	0	0	4	2	100
3	Professional Core Course	PCC-CSE 502	Formal Language & Automata Theory	3	0	0	3	100
4	Professional Core Course	PCC-CSE 503	Object Oriented Programming	2	0	0	2	100
		PCC-CSE 553	Object Oriented Programming Laboratory	0	0	4	2	100
5	Professional Elective Course	PEC-CSE I	Professional Elective-I	3	0	0	3	100
6	Mandatory Course	MC-HU 501	Constitution of India	3	0	0	0	100*
7	Humanities & Social Sciences including Management Course	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
<b>Total:</b>							<b>19</b>	<b>800</b>

PEC-CSE I	
Paper Code	Paper Name
PEC-CSE 511 (a)	Software Engineering
PEC-CSE 511 (b)	Advanced Algorithms
PEC-CSE 511 (c)	Advanced Computer Architecture
PEC-CSE 511 (d)	Real Time Systems

\*Marks for this paper will not reflect in total marks for the semester

Course Code	ESC-EC501(For Theory),				
Category	Engineering Science Courses (ESC)				
Course Title	Signals and Systems				
Scheme and Credits	L	T	P	Credit	Semester-V
	3	0	0	3	
Pre-requisites (if any)	---				

#### Objectives of the course:

- To impart the basic concepts of different signals and systems
- To understand the Fourier analysis of continuous and discrete time signals.
- To evaluate the time and frequency response of Continuous and Discrete time systems

#### Theory Syllabus

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction signals and systems:</b> Definition of Signal, Classification of signals: Continuous & Discrete time, Even & Odd, Periodic & Aperiodic, Deterministic & Random, Energy & Power Signals. Discussion about elementary signal forms: Exponential, Sinusoidal, Unit Step, Unit Impulse, Unit Ramp etc. Transformation of independent variables: Time Shifting, Time Scaling & Time Inversion. Introduction to System and basic System Properties.	<b>8L</b>
<b>2.</b>	<b>Fourier analysis of continuous and discrete time signals:</b> Introduction, Fourier series representation of continuous time periodic signals, Convergence of the Fourier series, Properties of Continuous time Fourier series, Aperiodic signal representation by Fourier Transform, Fourier Transform of some useful functions, Properties of Fourier Transform, Convolution: Time and Frequency Convolution. Parseval's Theorem for Energy & Power Signals, Energy and Power Spectral Density Functions, Properties of ESD and PSD. Auto and Cross correlation properties of Energy and Power signals. Concept of distortion less transmission through LTI systems. Introduction, Discrete Time Fourier Transform of Aperiodic signals, Properties of Discrete Time Fourier Transform (DTFT). Discrete Time Fourier Transform of Periodic signals. Discrete Time LTI systems characterized by Linear Constant-Coefficient Difference.	<b>16L</b>
<b>3.</b>	<b>Sampling :</b> Sampling theorem, impulse train sampling, zero order hold, interpolation, and aliasing. Discrete time sampling.	<b>4L</b>

<b>4.</b>	<b>Continuous and discrete time lti system:</b> Introduction, Continuous time Unit Impulse response and Convolution integral, Convolution sum for discrete time LTI systems. Properties of LTI Systems. Static & Dynamic LTI Systems, Invertibility of LTI Systems, Causality & Stability of LTI Systems, Paley-Wiener Criteria. Z –Transform: Introduction, The Z Transform, The Region of Convergence (ROC) for the z Transform, Properties of Z Transform. The Inverse Z Transform. Analysis and Characterization of continuous and discrete time LTI systems.	<b>14L</b>
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text/Reference Books:

1. Signals and Systems: Alan V. Oppenheim & Alan S. Willsky, P.H.I.
2. Signals and Systems: P. Ramesh Babu, R.Anandanatarajan,Scitech Pub.
3. Signals and Systems: Simon Haykin & Barry Van Veen, Wiley.
4. Signals and Systems: T K Rawat, Oxford Publication
5. Signals and Systems: V.Krishnaveni, A.Rajeswari,Wiley.
6. Principles of Signal Processing and Linear Systems: B.P.Lathi, Oxford Pub.
7. Signals and Systems: John Alan Stuller,Cengage Learning.
8. Digital Signal Processing: J.G.Proakis and Manolakis Pearson Edu.

### **Course Outcomes:**

After successful completion of the course student will be able to

- Understand about various types of signals and systems, classify them, analyse them, and perform various operations on them.
- Understand the use of transforms in analysis of signals and system in continuous and discrete time domain.
- Evaluate the time and frequency response of Continuous and Discrete time systems which are useful to understand the behaviour of electronic system.

Course Code	PCC-CSE 501 (For Theory), PCC-CSE 551 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course Title	Database Management Systems (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	4	5	
Pre-Requisites (if any)	PCC-CSE 403				



### Objectives of the Course:

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
- To understand and use data manipulation language to query, update, and manage a database.
- To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, and intelligent database, Client/Server (Database Server), Data Warehousing.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

### Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	<b>Database System Architecture:</b> Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML). <b>Data Models:</b> Entity-Relationship Model, Network Model, Relational and Object Oriented Data Models, Integrity Constraints, Data Manipulation Operations.	6L
2.	<b>Relational Query Languages:</b> Relational Algebra, Tuple and Domain Relational Calculus, SQL3, DDL and DML Constructs, Open Source and Commercial DBMS - MYSQL, ORACLE, DB2, SQL Server. <b>Relational Database Design:</b> Domain and Data Dependency, Armstrong's Axioms, Normal forms, Dependency Preservation, Lossless Design. <b>Query Processing and Optimization:</b> Evaluation of Relational Algebra Expressions, Query Equivalence, Join Strategies, Query Optimization Algorithms.	12L
3.	<b>Storage Strategies:</b> Indices, B-trees, Hashing.	6L
4.	<b>Transaction Processing:</b> Concurrency Control, ACID Property, Serializability of Scheduling, Locking and Timestamp Based Schedulers, Multi-Version and Optimistic Concurrency Control Schemes, Database Recovery.	6L
5.	<b>Database Security:</b> Authentication, Authorization and Access Control, DAC, MAC and RBAC Models, Intrusion Detection, SQL Injection.	6L
6.	<b>Advanced Topics:</b> Object Oriented and Object Relational Databases, Logical Databases, Web Databases, Distributed Databases, Data Warehousing and Data Mining.	6L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. “Database System Concepts”, 6th Edition by Abraham Silberschatz, Henry F.Korth, S. Sudarshan, McGraw-Hill.
2. “Principles of Database and Knowledge – Base Systems”, Vol 1 by J. D. Ullman, Computer Science Press.
3. “Fundamentals of Database Systems”, 5th Edition by R. Elmasri and S. Navathe, Pearson Education
4. “Foundations of Databases”, Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley

**Laboratory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Practical Period</b>
<b>1.</b>	<b>Creating Database:</b> Creating a Database, Creating a Table Specifying Relational Data Types, Specifying Constraints and Creating Indexes.	<b>8P</b>
<b>2.</b>	<b>Table and Record Handling:</b> Use of INSERT, SELECT and INSERT together, DELETE, UPDATE, TRUNCATE, DROP and ALTER Statements.	<b>8P</b>
<b>3.</b>	<b>Retrieving Data from a Database:</b> The SELECT Statement, Using the WHERE clause, Using Logical Operators in the WHERE clause, Using IN, BETWEEN, LIKE, ORDER BY, GROUP BY and HAVING Clause, Using Aggregate Functions, Combining Tables Using JOINS and Sub-queries.	<b>12P</b>
<b>4.</b>	<b>Database Management:</b> Creating Views, Creating Column Aliases, Creating Database Users, Using GRANT and REVOKE.	<b>8P</b>
<b>5.</b>	<b>PL/SQL:</b> Writing Oracle PL/SQL Procedure, Cursors in PL/SQL.	<b>8P</b>
<b>6.</b>	Database design using E-R model and Normalization, Design and implementation of some on line system [e.g. Library Management System]	<b>12P</b>
	<b>Total</b>	<b>56P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. SQL, PL/SQL by Ivan Bayross, BPB Publications.
2. Oracle PL/SQL Programming, 6th Edition - O'Reilly Media By Steven Feuerstein, Bill Pribyl.

**Course Outcomes:**

After successful completion of the course students should demonstrate the ability to:

- Write relational algebra expressions for a given query and optimize the developed expressions.
- Design the databases using E-R method and normalization for a given specification of the requirement.
- Write SQL queries in Open source and Commercial DBMS -MYSQL, ORACLE, and DB2 for a given specification construct.
- Optimize the execution of a given query using Query optimization algorithms.
- Determine the transaction atomicity, consistency, isolation, and durability for a given transaction-processing system.
- Implement the isolation property, including locking, time stamping based on concurrency control and serializability of scheduling.

Course code	PCC-CSE 502 (For Theory)				
Category	Professional Core Course (PCC)				
Course title	Formal Language & Automata Theory				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 401				

**Objectives of the course:**

Throughout the course, students will be expected to demonstrate their understanding of Formal Language & Automata Theory by being able to do each of the following:

- Develop a formal notation for strings, languages and machines.
- Design finite automata to accept a set of strings of a language.
- Prove that a given language is regular and apply the closure properties of languages.
- Design context free grammars to generate strings from a context free language and convert them into normal forms.
- Prove equivalence of languages accepted by Push Down Automata and languages generated by context free grammars.
- Identify the hierarchy of formal languages, grammars and machines.
- Distinguish between computability and non-computability and Decidability and undecidability.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.	<b>2L</b>
<b>2.</b>	<b>Regular Languages and Finite Automata:</b> Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata.	<b>10L</b>
<b>3.</b>	<b>Context-Free Languages and Pushdown Automata:</b> Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.	<b>18L</b>
<b>4.</b>	<b>Context-Sensitive Languages:</b> Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	<b>3L</b>
<b>5.</b>	<b>Turing Machines:</b> The basic model for Turing machines (TM), Turing recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.	<b>6L</b>
<b>6.</b>	<b>Undecidability:</b> Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice's theorem, undecidable problems about languages.	<b>3L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. "Introduction to Automata Theory, Languages, and Computation", John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Pearson Education Asia.
2. "Elements of the Theory of Computation", Harry R. Lewis and Christos H. Papadimitriou, Pearson Education Asia.
3. "Automata and Computability, Undergraduate Texts in Computer Science", Dexter C. Kozen, Springer.
4. "Introduction to the Theory of Computation", Michael Sipser, PWS Publishing.
5. "Introduction to Languages and The Theory of Computation", John Martin, Tata McGraw Hill.

6. “Theory of Computer Science: Automata, Languages and Computation”, K.L.P. Mishra and N. Chandrasekaran, PHI Learning Private Limited.
7. “Formal Languages and Automata Theory”, C.K. Nagpal, Oxford University Press.

### Course Outcomes:

On completion of the syllabus, students will be able to:

1. Write a formal notation for strings, languages and machines.
2. Design finite automata to accept a set of strings of a language.
3. For a given language determine whether the given language is regular or not.
4. Design context free grammars to generate strings of context free language.
5. Determine equivalence of languages accepted by Push Down Automata and languages generated by context free grammars
6. Write the hierarchy of formal languages, grammars and machines.
7. Distinguish between computability and non-computability and Decidability and undecidability.

Course code	PCC-CSE 503 (For Theory), PCC-CSE 553 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Object Oriented Programming (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – V
	2	0	4	4	
Pre-requisites (if any)	ESC-CSE 201, PCC-CSE 301				

### Objectives of the course:

The course will introduce standard tools and techniques for software development, using object oriented approach, use of a version control system, an automated build process, an appropriate framework for automated unit and integration tests.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Abstract data types (ADT) and their specification:</b> How to implement an ADT. Concrete state space, concrete invariant, abstraction function. Implementing operations, illustrated by the Text example.	<b>2L</b>
<b>2.</b>	<b>Features of object-oriented (OO) programming:</b> Encapsulation, object identity, polymorphism – but not inheritance.	<b>2L</b>
<b>3.</b>	<b>Inheritance in OO design</b>	<b>2L</b>
<b>4.</b>	<b>Commands as methods and as objects</b>	<b>2L</b>
<b>5.</b>	<b>Implementing OO language features</b>	<b>3L</b>
<b>6.</b>	<b>Memory management</b>	<b>2L</b>
<b>7.</b>	<b>Generic types and collections</b>	<b>3L</b>
<b>8.</b>	<b>Graphical User Interfaces (GUIs):</b> Graphical programming with Scala/ Swing	<b>3L</b>
<b>9.</b>	<b>Design patterns:</b> Introduction and classification. The iterator pattern, Model-view-controller pattern	<b>3L</b>
<b>10.</b>	<b>The software development process using Unified Modeling Language (UML)</b>	<b>6L</b>
	<b>Total:</b>	<b>28L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Program Development in Java, Barbara Liskov, Addison-Wesley, 2001
2. The Unified Modeling Language User Guide, G. Booch, J. Rumbaugh, I. Jacobson, Pearson Education.
3. Java: The Complete Reference, H. Schildt, McGraw Hill Education
4. C++: The Complete Reference, H. Schildt, McGraw Hill Education
5. The Design and Evolution of C++, B. Stroustrup, Addison-Wesley.
6. Java How To Program, H. M. Deitel and P. J. Deitel, Prentice Hall
7. C++ How To Program, H. M. Deitel and P. J. Deitel, Prentice Hall
8. Object Oriented Programming with C++, E. Balagurusamy, McGraw Hill Education
9. Programming with Java: A Primer, E. Balagurusamy, McGraw Hill Education
10. Object Oriented Programming in Turbo C++, R. Lafore, Galgotia Publications Pvt Ltd
11. Java 8 Programming Black Book, D. T. Editorial Service, Dreamtech Press
12. Introduction to Java programming, Y. Daniel Liang, Pearson education.
13. Core Java, Volume I: Fundamentals, C. S. Horstmann and G. Cornell, Pearson Education.
14. Core Java(TM) 2, Volume II--Advanced Features, C. S. Horstmann and G. Cornell, Pearson Education.

**Laboratory Syllabus:**

Module	Detailed Description	Practical Period
1.	Programs to build class, constructor, doing overloading, inheritance, overriding	11P
2.	Programs on Function overloading, Programs on developing interfaces, inheritance, extending interfaces, Programs on creating and accessing packages, Polymorphism and related problems.	15P
3.	Thread programming, Programs on handling errors and exceptions, Programs on Enumerations, Autoboxing and Annotations, Generic class programming, Programming on Input/ Output, GUI programming	15P
4.	Object Oriented Software design using UML Modeling Tool: Forward engineering (Code and Test case generation) and Reverse Engineering using UML diagram.	15P
		56P
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Program Development in Java, Barbara Liskov, Addison-Wesley, 2001
2. The Unified Modeling Language User Guide, G. Booch, J. Rumbaugh, I. Jacobson, Pearson Education.
3. Java: The Complete Reference, H. Schildt, McGraw Hill Education
4. C++: The Complete Reference, H. Schildt, McGraw Hill Education
5. The Design and Evolution of C++, B. Stroustrup, Addison-Wesley.
6. Java How To Program, H. M. Deitel and P. J. Deitel, Prentice Hall
7. C++ How To Program, H. M. Deitel and P. J. Deitel, Prentice Hall
8. Object Oriented Programming with C++, E. Balagurusamy, McGraw Hill Education
9. Programming with Java: A Primer, E. Balagurusamy, McGraw Hill Education
10. Object Oriented Programming in Turbo C++, R. Lafore, Galgotia Publications Pvt Ltd
11. Java 8 Programming Black Book, D. T. Editorial Service, Dreamtech Press
12. Introduction to Java programming, Y. Daniel Liang, Pearson education.
13. Core Java, Volume I: Fundamentals, C. S. Horstmann and G. Cornell, Pearson Education.
14. Core Java(TM) 2, Volume II--Advanced Features, C. S. Horstmann and G. Cornell, Pearson Education.

**Course outcomes:**

After taking the course, students will be able to:

- Specify simple abstract data types and design implementations, using abstraction functions to document them.
- Recognize features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity.
- Name and apply some common object-oriented design patterns and give examples of their use.
- Design applications with an event-driven graphical user interface.

Course code	PEC-CSE 511(a)				
Category	Professional Elective Course (PEC)				
Course title	Software Engineering				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 201, PCC-CSE 501				

### Course Objectives:

To expose the students to the following:

- Software Development Life Cycle
- Software design
- Software Planning
- Development skills to construct software of high quality.
- Software Testing
- Software Reliability
- Software Maintenance.
- Software Certification.

### Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
<b>1.</b>	<p><b>Introduction:</b> Definition of Software engineering, Introduction to the notion of software engineering as a product, Characteristics of good software products, Introduction to the Engineering aspects of Software Products, Necessity of automation, Job responsibilities of programmers and Software Engineers as Software Developers, Software development process models.</p> <p><b>Software Development Life Cycle and Process Models:</b> Requirement analysis, Software Design, Coding, Testing, Maintenance. Code and Fix Model, Waterfall Model, Prototyping model, Iterative Enhancement Model, RAD Model, Evolutionary process Model, Unified process Model, Spiral Model, Selection of Life Cycle Models, Role of Management in Software Development.</p> <p><b>Software certification:</b> Requirement of certification, Types, Certification of: Product, Process, Person, Third party certification.</p>	<b>14L</b>
<b>2.</b>	<p><b>Software Requirement Specification:</b> Problem analysis, Requirement Specification, Requirement Types, Requirement Gathering Techniques, feasibility Study Validation, metrics, Use Case diagram, ER Diagram.</p> <p><b>Techniques for Software Size and Cost Estimation: Software Project Planning:</b> Line of Codes method, Function Point Analysis for size estimation, Static Single variable and Static Multi Variable models for Cost Estimation. COCOMO and COCOMO-II.</p>	<b>8L</b>



3.	<b>System Design:</b> Problem Partitioning, Abstraction, Top-down and bottom-up design, Structured approach, Modularity, Coupling and cohesion, DFD and Structure chart. <b>Coding:</b> Top-down and Bottom up approach, Structured Programming, program style and internal documentation, Verification, Validation, Metrics, Types of metrics, Token Count methodology, Data Sharing among modules, Information flow metrics, Basic and revised information flow model.	9L
4.	<b>Testing:</b> Levels of testing, Alpha Testing, Beta Testing, Functional Testing, Boundary Value Analysis, Introduction to the technique for testing real time systems, Test case specification. <b>Software Reliability:</b> Software reliability, Reliability Curve, failure, Fault, Risk Management, Software quality, Software quality assurance models :McCall Software Quality model, Boehm Software Quality model, ISO 9000, ISO 9126 <b>Software Maintenance:</b> Categories of maintenance, problems during maintenance, Maintenance Process, Maintenance models: Quick and Fix model, Iterative Enhancement model, Reuse oriented model, Boehm's model, Taute Maintenance model.	11L
	<b>TOTAL:</b>	42L
	<b>Total Week Required:</b>	14
	<b>No. of Week Reserved:</b>	02

**Books: Text and/or Reference:**

1. R. S. Pressman, Software Engineering: A Practitioners Approach, McGraw Hill.
2. R. Mall, Fundamentals of Software Engineering, PHI Publication.
3. K. K. Aggarwal and Y. Singh, Software Engineering, New Age International Publishers.
4. C. Ghezzi, M. Jarayeri, D. Manodrioli, Fundamentals of Software Engineering, PHI Publication.
5. I. Sommerville, Software Engineering, Addison Wesley.
6. P. Jalote, Software Engineering, Narosa Publication
7. S. L. Pfleeger, Software Engineering : The Production of Quality Software, Macmillan Pub Co.

**Course Outcomes:**

On completion of the course students will be able to:

- Define various software application domains and remember different process model used in software development.
- Justify role of SDLC in Software Project Development.
- Explain needs for software specifications and classify different types of software requirements and their gathering techniques.
- Convert the requirements model into the design model and demonstrate use of different diagrams to explain the design architecture.
- Plan by calculating probable cost and size of the project through different cost and size estimation techniques.
- Evaluate different reliability parameters of software and define risk management strategy.
- Design Test cases and identify the realistic maintenance schedule for Software.

Course code	PEC-CSE 511(b) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Advanced Algorithms				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 201, PCC-CSE 301, PCC-CSE 404				

**Course Objectives:** Throughout the course students will be able to

- To learn the basics of randomized, parallel, approximation and online algorithm.
- To learn how to analyze and design the different algorithm for application.
- To build concepts of different NP problem.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Randomized Algorithm-</b> Numerical probabilistic algorithms, Las Vegas and Monte Carlo algorithms, Game-theoretic techniques, Linearity of expectation, Markov inequality, Chebyshev's inequality, Examples and analysis of: Hiring Assistant Problem, Randomized selection, Skip list and graph problem.	<b>5L</b>
<b>2.</b>	<b>Parallel Algorithms</b> Introduction, Models, speedup and efficiency, Some basic techniques, Examples from graph theory, sorting. Parallel algorithms and its time complexity.	<b>6L</b>
<b>3.</b>	<b>NP- Completeness</b> - Reduction revisited; NP-Completeness proof of different problems: CLIQUE, VERTEX COVER, INDEPENDENT SET, SET COVER	<b>7L</b>
<b>4.</b>	<b>Approximation Algorithms</b> - Introduction, Combinatorial Optimization, approximation factor, PTAS, FPTAS, Approximation algorithms for vertex cover, set cover, TSP, knapsack, bin packing, subset-sum problem etc. Analysis of the expected time complexity of the algorithms.	<b>7L</b>
<b>5.</b>	<b>Online Algorithms:</b> Overview, Online scheduling and online Steiner tree, Online Bipartite matching, Online learning and multiplicative weights algorithm.	<b>6L</b>
<b>6.</b>	<b>Linear Programming:</b> Introduction, Convexity, Duality, Linear Programming formulation and Algorithm	<b>5L</b>
<b>7.</b>	<b>Data Structures:</b> More Advanced Solutions to Basic Data Structuring Problems: Fibonacci Heaps. Van Emde Boas Priority Queues. Dynamic Data Structures for Graph Connectivity/Reachability. Hashing (Open addressing).	<b>6L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, 2nd Edition, Cambridge University press, Cambridge, MA, 1995.
2. Thomas H. Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein. Introduction to Algorithms. 3rd ed. MIT Press, 2009
3. S. G. Akl, The Design and Analysis of Parallel Algorithms, Prentice-Hall, 1989.
4. M. J. Quinn, Designing Efficient Algorithms for Parallel Computers, McGraw Hill Higher Education, 1987
5. J. Kleinberg and E. Tardos, Algorithm Design, Pearson.
6. D. V. Williamson and D. B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press.
7. Borodin, Allan, and Ran El-Yaniv, Online Computation and Competitive Analysis, Cambridge University Press.
8. S. Arora and B. Barak, Computational Complexity: A Modern Approach, Cambridge University Press.
9. M. Mitzenmacher and E. Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press.

**Course Outcomes:**

After undergoing the course students will be able to

- Acquire a basic concept of advance application of different algorithm.
- Implement the algorithm in different fields.
- Compare the efficiency of different algorithms for a given problem.
- Develop a research skill to efficiently solve the problem by algorithm.

Course code	PEC-CSE 511(c)				
Category	Professional Elective Course (PEC)				
Course title	Advanced Computer Architecture				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 302, PCC-CSE 402				

**Course Objectives:**

To expose the students to the following

- Parallelism within Computer Systems
- Pipelined Processors
- The current state of art Interconnection Networks
- To provide the knowledge on Vector Processors
- Understanding Memory Interleaving
- Concepts of Multiprocessors

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Evolution of computer architecture, Flynn's classification, System performance. <b>Parallelism, Partitioning and Flow Mechanism:</b> Conditions of parallelism – Data, Control and Resource dependencies, Bernstein's Conditions, Hardware & Software parallelism; Program Partitioning & Scheduling – Grain Sizes & Latency, Grain Packing & Scheduling, Static Multiprocessor Scheduling; Program Flow Mechanisms - Control Flow, Data Flow, Demand Driven Mechanisms, comparisons.	<b>10L</b>
<b>2.</b>	<b>Advanced Processor Technology:</b> RISC, CISC, Symbolic Processor and characteristics, Difference between RISC and CISC. <b>Pipelining - An Instruction Level Parallelism (ILP):</b> Linear pipelining – Speedup, Efficiency, Throughput; Non-linear pipelines – Reservation tables & Latency Analysis; Instruction pipelines – phases, mechanisms, pipeline hazards - structural, data and control hazards, dynamic branch prediction; Dynamically Scheduled pipelines with Scoreboard, Collision free scheduling, Minimal Average Latency (MAL);	<b>12L</b>
<b>3.</b>	<b>Vector Processing:</b> Vector Instructions, Architecture of a Vector processor. <b>Array Processors:</b> SIMD machines, Loosely and Tightly Coupled SIMD machines, Masking schemes, Components of a SIMD Processing Element (PE), SIMD Interconnection networks - Static and Dynamic networks, Multistage Dynamic networks - Crossbar Switches.	<b>10L</b>
<b>4.</b>	<b>Multiprocessors - Exploiting Thread Level Parallelism (TLP):</b> Loosely Coupled Multiprocessors: Message Transfer System (MTS); Tightly Coupled Multiprocessors: Shared Memory Processors, UMA machines, NUMA machines, Cache coherence - cache coherence problem, snooping protocol and directory based protocol, Interconnections – time shared or common bus, multiport memory; <b>Memory Interleaving:</b> Low-Order Interleaving, High-Order Interleaving techniques, Increase in Memory Bandwidth, Interleaving and fault tolerance.	<b>10L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. "Computer Organization and Design: The Hardware/Software Interface", 5th Edition by David A. Patterson and John L. Hennessy, Elsevier.
2. "Computer Organization and Embedded Systems", 6th Edition by Carl Hamacher, McGraw Hill Higher Education.

3. “Computer Architecture and Organization”, 3rd Edition by John P. Hayes, WCB/McGraw-Hill
4. “Computer Organization and Architecture: Designing for Performance”, 10th Edition by William Stallings, Pearson Education.
5. “Parallel processing and Computers Architecture” by K. Hwang, F. Briggs, Tata McGraw Hill
6. “Advanced Computer Architecture” by Kai Hwang, McGraw Hill International.

#### Course Outcomes:

- Being acquainted with the features of Pipelined Processors.
- Understanding the Properties and Routing Patterns of Interconnection Network Architectures.
- Conceptualize Vector Processors and operations of vector instructions.
- Design of memory interleaving techniques.
- Illustrations on Loosely and Tightly coupled Multiprocessor systems and different data access mechanisms.

Course code	PEC-CSE 511(d)				
Category	Professional Elective Course (PEC)				
Course title	Real Time Systems				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 403				

#### Course Objectives

Given the knowledge of operating systems students will be able to design and implement systems that can be verified to meet the timing requirements.

#### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction</b> Definition, Real time characteristics, Basic issues of real time operating system, Typical Real Time Applications, Timing constraints, Modeling of timing constraints etc.	<b>8L</b>
<b>2.</b>	<b>Real Time Scheduling</b> Basics of Real Time Scheduling, Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Rate Monotonic scheduling Algorithm, Scheduling aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems. Issues related with scheduling etc.	<b>12L</b>

<b>3.</b>	<b>Resources Sharing</b> Sharing resources among real time tasks, highest locker, Priority-Ceiling Protocols and its analysis, handling task dependencies, Real time task scheduling on multiprocessor and distributed system, Clock synchronization in real time distributed system etc.	<b>10L</b>
<b>4.</b>	<b>Real Time Communication</b> Basic Concepts in Real time Communication and a few basic issues, Real time communication in LAN, Communication protocols, Communication over packed switched network etc.	<b>8L</b>
<b>5.</b>	<b>Real Time Databases</b> Introduction	<b>4L</b>
	<b>TOTAL:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

- 1.Real-Time Systems -Jane W.S. Liu, Pearson Education
- 2.Real Time Systems :-C.M. Krishna & Kang G. Shin, McGraw Hill
- 3.Real-Time Systems: Theory and Practice-Rajib Mal, Pearson Education India

**Course Outcomes:**

- Enumerate the need and the challenges in the design of hard and soft real time systems.
- Compare different scheduling algorithms and the schedulability criteria.
- Determine schedulability of a set of periodic tasks given a scheduling algorithm.
- Develop algorithms to decide the admission criterion of sporadic jobs and the schedule of aperiodic jobs.
- Integrate resource access mechanisms with the scheduling techniques and develop integrated schedulability criteria.

Course code	MC-HU501				
Category	Mandatory Course (MC)				
Course title	Constitution of India				
Scheme and Credits	L	T	P	Credits	Semester V
	3	0	0	0	
Pre-requisites (if any)					

## Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	<b>Introduction and Basic Information about Indian Constitution:</b> Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, The Role of the Constituent Assembly. <b>Features:</b> Citizenship, Preamble and Salient features of the Constitution of India, Fundamental Rights and its Restriction and limitations in different Complex Situations, Fundamental Duties and its Scope and significance in Nation building, Directive Principles of State Policy (DPSP) & it's present relevance in our society with examples.	8L
2.	<b>Union Government and its Administration:</b> Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, Prime Minister and Council of ministers, Union Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism.	8L
3.	<b>State Government and its Administration:</b> Governor: Role and Position, Chief Minister State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370,371,371J) for some States. State Secretariat: Organisation, Structure and Functions	8L
4.	<b>Constitutional Provisions/ Local Administration/Human Rights:</b> Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes. Institute and Bodies for the welfare of SC/ST/OBC and women. <b>District's Administration head:</b> Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Panchayati raj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy <b>Human Rights/values</b> – Meaning and Definitions, Legislative Specific Themes in Human Rights and Functions/ Roles of National Human Rights Commission of India. Human Rights (Amendment Act)2006.	9L
5	<b>Elections, Amendments and Emergency Provisions:</b> Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments - 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgments with Explanation and its impact on society (from the list of Supreme Court Judgments). Emergency Provisions, types of Emergencies and its consequences.	9L
	<b>Total</b>	<b>42L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

**Books: Text and/or Reference/Web Links and Video Lectures:**

1. Durga Das Basu (DD Basu): “Introduction to the Constitution on India”, (Students Edition.)Prentice – Hall EEE, 19th / 20th Edn., (Latest Edition) or 2008.
2. Shubham Singles, Charles E. Haries, and Et al : “Constitution of India and Professional Ethics” by Cengage Learning India Private Limited, Latest Edition – 2018.
3. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, “Engineering Ethics”, Prentice – Hall of India Pvt. Ltd. New Delhi, 2004
4. M.V.Pylee, “An Introduction to Constitution of India”, Vikas Publishing, 2002
5. Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi

**Course Outcomes:**

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

- Have general knowledge and legal literacy about Indian Constitution and thereby it helps to take up competitive examinations & to manage/face complex societal issues in society.
- Understand state and central policies (Union and State Executive), fundamental Rights & their duties.
- Understand Electoral Process, Amendments and special provisions in Constitution.
- Understand powers and functions of Municipalities, Panchayats and Co-operative Societies, with Human Rights and NHRC

Course code	HSM-HU 581 (For Laboratory)				
Category	Humanities Science & Management (HSM)				
Course title	Grooming & Personality Development				
Scheme and Credits	L	T	P	Credits	Semester – V
	0	0	2	1	
Pre-requisites (if any)	Basic knowledge of speaking and writing in English				

**Laboratory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Practical Period</b>
<b>1.</b>	<b>Self-Development Skills:</b> Introduction to personality; Self-Esteem and Self-Confidence; problem solving; Stress Management; Goal-Setting	<b>5P</b>
<b>2.</b>	<b>Public Speaking:</b> Importance; Types, Mechanics; Pillars of Public Speaking; Overcoming fear of Public Speaking	<b>5P</b>



<b>3.</b>	<b>Oral presentation and professional speaking:</b> Basics of English pronunciation public preparing for a speech.; Elements of effective presentations, Body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; Organizing the presentation to suit the audience and content	<b>6P</b>
<b>4.</b>	<b>Career Oriental Communication:</b> Design and Style applying for a job: Language and format of job application; Resume & bio-data	<b>5P</b>
<b>5</b>	<b>Job Interview:</b> Purpose and process, language and style to be used, types of interview question and how to answer them	<b>7P</b>
	<b>Total:</b>	<b>28P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Development and Soft Skills. Barun K. Mitra. Oxford University Press, New Delhi: 2016.
2. Personality Development: Transform Yourself. Rajiv K. Mishra. Rupa Publications, India: 2012.
3. Hurlock. Personality Development. Elizabeth B. McGraw Hill Education, 2017.
4. Personality Development and Career management. R. M. Onkar. S. Chand Publication, India: 2010.
5. Managing Soft Skills for Personality Development. Ed. by B. N. Ghosh. McGraw Hill, India: 2012.

**Course outcomes:**

On completion of the course students will be able to

- Groom themselves through the knowledge of personality development attributes –self confidence, problem solving and stress management skills etc.
- Deliver confidently an organized, refined, professional and credible speech for better suit the audience.
- Acquire the basic concepts of English pronunciation and elements of effective presentations, body language and use of voice during presentation.
- Connect with the audience during presentation and exhibit the art of projecting a positive image while speaking and preparing a model presentation.
- Learn the effective language for writing job application, resume and bio-data.
- Familiar with common interview questions and the techniques to answer them

**Semester VI (Third year) Curriculum**  
**Branch/Course: Computer Science and Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Core Course	PCC-CSE 601	Compiler Design	3	0	0	3	100
		PCC-CSE 651	Compiler Design Laboratory	0	0	4	2	100
2	Professional Core Course	PCC-CSE 602	Computer Networks	3	0	0	3	100
		PCC-CSE 652	Computer Networks Laboratory	0	0	4	2	100
2	Professional Core Course	PCC-CSE 653	Python Programming Laboratory	0	0	4	2	100
3	Professional Elective Course	PEC-CSE II	Professional Elective-II	3	0	0	3	100
4	Professional Elective Course	PEC-CSE III	Professional Elective-III	3	0	0	3	100
5	Open Elective Course	OEC-X 621 <sup>#</sup>	Open Elective I	3	0	0	3	100
6	Project	PROJ-CSE 691	Project-I	0	0	6	3	100
7	Humanities & Social Sciences including Management Course	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
<b>Total:</b>							<b>25</b>	<b>1000</b>

PEC-CSE II		PEC-CSE III	
Paper Code	Paper Name	Paper Code	Paper Name
PEC-CSE 611(a)	Artificial Intelligence	PEC-CSE 612(a)	Advanced Operating Systems
PEC-CSE 611(b)	Computer Graphics	PEC-CSE 612(b)	Soft Computing
PEC-CSE 611(c)	Distributed Systems	PEC-CSE 612(c)	Digital Signal Processing
PEC-CSE 611(d)	Embedded Systems	PEC-CSE 612(d)	Data Mining

# Here X denotes the code of the offering departments such as HU/EC/EI/M. Refer to Appendix-I

Course code	PCC-CSE601(Theory) & PCC-CSE 651(Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Compiler Design (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	4	5	
Pre-requisites (if any)	PCC-CSE 301, PCC-CSE 502				

#### Objectives of the course:

- To understand and list the different stages in the process of compilation.
- Identify different methods of lexical analysis.
- Design top-down and bottom-up parsers.
- Identify synthesized and inherited attributes.
- Develop syntax directed translation schemes.
- Develop algorithms to generate code for a target machine

#### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<p><b>Introduction :</b> Overview of the Translation Process, A Simple Compiler, Difference between interpreter, assembler and compiler. Overview and use of linker and loader, types of Compiler, Analysis of the Source Program, The Phases of a Compiler, Cousins of the Compiler, The Grouping of Phases, Lexical Analysis, Hard Coding and Automatic Generation Lexical Analyzers, Front-end and Back-end of compiler, pass structure.</p> <p><b>Lexical Analysis :</b> Introduction to Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, A Language for Specifying Lexical Analyzers, Finite Automata From a Regular Expression, Design of a Lexical Analyzer Generator, Optimization of DFA.</p>	<b>10L</b>
<b>2.</b>	<p><b>Syntax Analysis :</b> Context-free languages and grammars, push-down automata, LL(1) grammars and top-down parsing, operator grammars, LR(O), SLR(1), LR(1), LALR(1) grammars and bottom-up parsing, ambiguity and LR parsing, LALR(1) parser generator (yacc, bison).</p> <p><b>Semantic Analysis:</b> Attribute grammars, syntax directed definition, evaluation and flow of attribute in a syntax tree.</p>	<b>15L</b>

<b>3.</b>	<b>Symbol Table:</b> Its structure, symbol attributes and management  <b>Run-time environment:</b> Procedure activation, parameter passing, value return, memory allocation, and scope.  <b>Intermediate Code Generation:</b> Translation of different language features, different types of intermediate forms.	<b>9L</b>
<b>4.</b>	<b>Code Improvement (optimization): Analysis:</b> control-flow, data-flow dependence etc.; Code improvement local optimization, global optimization, loop optimization, peep-hole optimization etc. Architecture dependent code improvement: instruction scheduling (for pipeline), loop optimization (for cache memory) etc.  <b>Register allocation and target code generation Advanced topics:</b> Type systems, data abstraction, compilation of Object Oriented features and non-imperative programming languages.	<b>8L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. V.Aho, R.Sethi and J. D.Ullman, Compiler Principles, Techniques, and Tools, Addison- Wesley
2. A. I.Holub, Compiler Design in C, Prentice-Hall.
3. S. Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann
4. Chattopadhyay, Santanu. Compiler Design. PHI Learning Pvt. Ltd., 2005
5. Tremblay and Sorenson Compiler Writing-McGraw-Hill International

**Course Outcomes:**

Students should demonstrate the ability to:

- For a given grammar specification develop the lexical analyser
- For a given parser specification design top-down and bottom-up parsers.
- Develop syntax directed translation schemes.
- Develop algorithms to generate code for a target machine

**Laboratory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Practical Period</b>
<b>1</b>	Implementation of a C program in order to identify whether a given line is a comment or not Implementation of a C program to test whether a given identifier is valid or not	<b>3P</b>
<b>2</b>	Implementation of the following programs using Lex. a. Creation of a Lexer to take input from text file and count no of characters, no. of lines & no. of words. b. Counting of number of vowels and consonants in a given input string	<b>3P</b>

<b>3</b>	Implementation of the following programs using Lex. a. print out all numbers from the given file. b. printout all HTML tags in file. c. program which adds line numbers to the given file and display the same onto the standard output. d. program to count the number of comment lines in a given C program. Also eliminate them and copy that program into separate file.	<b>6P</b>
<b>4</b>	Design a lexical analyzer for given language using LEX and C	<b>6P</b>
<b>5</b>	To Study about Yet Another Compiler-Compiler (YACC). Creation of Yacc and Lex specification files to recognizes arithmetic expressions involving +, -, * and /. Creation Yacc and Lex specification files are used to generate a calculator which accepts integer and float type arguments.	<b>6P</b>
<b>6</b>	C program for constructing of LL (1) parsing.	<b>6P</b>
<b>7</b>	C program for constructing recursive descent parsing	<b>6P</b>
<b>8</b>	C program to implement LALR parsing	<b>6P</b>
	<b>Total:</b>	<b>42P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. V.Aho, R.Sethi and J. D.Ullman, Compiler Principles, Techniques, and Tools, Addison- Wesley
2. A. I.Holub, Compiler Design in C, Prentice-Hall.
3. S. Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann
4. D. Brown, J. Levine and T. Manson, lex & yacc , O'Reilly

**Course Outcomes:**

- Demonstrate a working understanding of the process of lexical analysis, parsing and other compiler design aspects.

Course code	PCC-CSE 602 (For Theory), PCC-CSE 652 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Computer Networks (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	4	5	
Pre-requisites (if any)	PCC-CSE 402, PCC-CSE 403				

**Objectives of the course:** Throughout the course, students will be expected to demonstrate their understanding of Computer Networks by being able to do each of the following:

- Become familiar with layered communication architectures (OSI and TCP/IP).
- Understand the client/server model and key application layer protocols.
- Understand the concepts of reliable data transfer and how TCP implements these concepts.

- Know the principles of congestion control and trade-offs in fairness and efficiency.
- Learn the principles of routing and the semantics and syntax of IP.
- Understand the basics of error detection including parity, checksums, and CRC.
- Familiarize the student with current topics such as security, network management, wireless networks, and/or other topics.

### Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	<p><b>Data communication Components:</b> Representation of data and its flow Networks , Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.</p> <p><b>Data Link Layer and Medium Access Sub Layer:</b> Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA.</p>	16L
2.	<b>Network Layer:</b> Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.	10L
3.	<b>Transport Layer:</b> Process to Process Communication, User Datagram Protocol (UDP),Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.	8L
4.	<b>Application Layer:</b> Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography.	8L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw-Hill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
3. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
4. Internetworking with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
5. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States of America.

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

- Conceptualize and explain the functionality of the different layers within network architecture.
- Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies, sub netting and routing mechanism.
- Demonstrate the operation of various routing protocols and their performance analysis.
- Illustrate design and implementation of data link, transport and network layer protocols within a simulated /real networking environment.
- Identify and discuss usual security issues regarding computer network protocols and applications.

**Laboratory Syllabus:**

Module	Detailed Description	Practical Period
1.	NIC Installation & Configuration (Windows/Linux), Familiarization with Networking Cables, Connectors Hubs, Switches, Gateway	8P
2.	Inter Process Communication using Message and Pipes.	6P
3.	Introduction Socket Programming, Implementation of simplex, duplex chatting, daytime server, echo server etc.	10P
4.	Study of Different Routing Protocols using Network Simulator.	16P
5.	Study of Network Congestion Control Algorithms Using Network Simulator.	16P
	<b>Total:</b>	<b>56P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. B. A. Forouzan , Data Communications and Networking, McGraw Hill Education
2. J. Walrand ,Communication Networks ,McGraw Hill Education
3. D. E. Comer ,Internetworking with TCP/IP, vol. 1, 2, 3,Pearson Education

4. W. R. Stevens, UNIX Network Programming(Vol I and II),Pearson Education
5. Kernighan and Ritchie, The UNIX programming environment , PHI

**Course outcomes:**

After the completion of this course, student will be able to

- Understand fundamental underlying principles of computer networking.
- Understand details and functionality of layered network architecture.
- Apply mathematical foundations to solve computational problems in computer networking.
- Analyze performance of various communication protocols.
- Practice packet /file transmission between nodes.
- Compare routing algorithms using simulator.

Course code	PCC-CSE 653				
Category	Professional Core Course (PCC)				
Course title	Python Programming Laboratory				
Scheme and Credits	L	T	P	Credit	Semester – VI
	0	0	4	2	
Pre-requisites (if any)	ESC-CSE 201, ESC-CSE251, PCC-CSE 503, PCC-CSE 553				

**Course Objectives:** Students will be able to learn

- primary fundamentals of python programming
- potential of python towards achievements modern computing requirements

**Laboratory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Practical Period</b>
1.	<b>Basics of Python:</b> Simple Programming with input/output statement, Variables, Data types and Operator understanding.	<b>6P</b>
2.	<b>Conditional and Loop Statement:</b> Programming with conditional blocks using if, else and elif, study of loops, range, continue, break, nested loop, list and dictionaries.	<b>12P</b>
3.	<b>String Operations:</b> Indexing, in operator, concatenation, repetition, different string methods.	<b>6P</b>
4.	<b>Function:</b> Function, arguments, returning value, local and global variable, implements searching and sorting algorithm, recursion	<b>12P</b>



5.	<b>Exception:</b> Basic exception handling program.	<b>1P</b>
6.	<b>File:</b> Basic file operation	<b>2P</b>
7.	<b>Classes and OOP Concepts:</b> Object-Oriented Programming, classes and working with instances, inheritance, method overloading, polymorphism.	<b>12P</b>
8.	<b>Design of Graphical User Interface</b>	<b>1P</b>
9.	<b>Packages:</b> Importing internal module as well as external modules in the code packages; understanding and their usage.	<b>4P</b>
	<b>Total</b>	<b>56P</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

#### Text/Reference Books:

1. Starting Out with Python (2009): Tonny Gaddis, Pearson
2. Beginning Python: Peter Norton, Alex Samuel, Wrox Publication
3. Think Python First Edition, by Allen B. Downey, Orielly publishing
4. Introduction to Computation and Programming Using Python. John V. Guttag, the MIT Press.

#### Course Outcomes:

After completion of this course, student will be able to

- To learn basics of Python
- To learn different packages in python
- To develop different application in python

Course code	PEC-CSE611(a)				
Category	Professional Elective Course (PEC)				
Course title	Artificial Intelligence				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	BSC-M 102, ESC-CSE 201				

#### Objectives of the course:

- To provide a strong foundation of fundamental concepts in Artificial Intelligence
- To provide a basic exposition to the goals and methods of Artificial Intelligence
- To enable the student to apply these techniques in applications which involve perception, reasoning and learning

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Definition of AI, Features of AI, Typical AI problems ,Practical Impact of AI ,Approaches to AI ,Limits of AI Today, AI History. Brief introduction to Agent technology.	<b>3L</b>
<b>2.</b>	<b>Problem Solving and Search techniques:</b> Solving problems by searching: problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies, heuristic search techniques, constraint satisfaction problems, stochastic search methods.	<b>10L</b>
<b>3.</b>	<b>Game Playing :</b> Perfect play, Resource limits, $\alpha$ - $\beta$ pruning, minimax search Games of chance, Games of imperfect information.	<b>3L</b>
<b>4.</b>	<b>Knowledge Representation and Reasoning:</b> Introduction to Logic, Syntax and semantics of first order logic, Using first order logic, assertions and queries in first-order logic, kinship domain, Wumpus world problem, Knowledge engineering in first order logic, Inference in first order logic- Propositional vs. first-order inference, Unification and lifting, Storage and retrieval, Forward chaining, Backward chaining, Resolution,	<b>8L</b>
<b>5.</b>	<b>Uncertain knowledge and Reasoning:</b> Uncertainty, Probabilistic Reasoning.	<b>3L</b>
<b>6.</b>	<b>Planning:</b> The Planning Problem, Planning with State-Space Search, Partial Order Planning, Planning Graph, Planning with Propositional Logic	<b>7L</b>
<b>7.</b>	<b>Learning:</b> Basic concept, Learning Spectrum, learning by taking advice, Learning in problem solving, Learning from examples, Explanation based learning.	<b>4L</b>
<b>8.</b>	<b>Introduction to logic programming using Prolog</b>	<b>4L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Stewart Russell and Peter Norvig. " Artificial Intelligence-A Modern Approach ", 2nd Edition, Pearson Education/ Prentice Hall of India, 2004
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 2003.
3. Nils J. Nilsson, "Artificial Intelligence: A new Synthesis", Harcourt Asia Pvt. Ltd., 2000
4. George F. Luger, "Artificial Intelligence-Structures and Strategies For Complex Problem Solving", Pearson Education / PHI, 2002.

**Course Outcomes:**

Students should demonstrate the ability to:

- Understand the various searching techniques, constraint satisfaction problem and example problems- game playing techniques.
- Apply these techniques in applications which involve perception, reasoning and learning.

- Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
- Acquire the knowledge of real world Knowledge representation.
- Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.

Course Code	PEC-CSE 611 (b)				
Category	Professional Elective Course (PEC)				
Course Title	Computer Graphics				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-Requisites (if any)	BSC-M 102, ESC-CSE 201, PCC-CSE 301, PCC-CSE 404				

#### Objectives of the Course:

- To provide comprehensive introduction about computer graphics system, mathematical logic to develop algorithms and computer programs for elementary graphic operations.
- To make the students familiar with techniques of clipping, two dimensional and three dimensional transformations.
- The computer graphics course prepares students for activities involving in design, development and testing of modeling, rendering, and shading.
- Develop scientific and strategic approach to solve complex problems in the domain of Computer Graphics.
- Apply the logic to develop animation and gaming programs.

#### Theory:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction to Computer Graphics &amp; Graphics Systems :</b> Overview Of Computer Graphics & Its Uses; Classification, Characteristics, Components & Applications of Computer Graphics; Basic Terminologies: Pixel, Resolution, Aspect Ratio; Raster Scan Display; Bit Planes, Color Depth, Color Palette, Frame Buffer; Video Controller, General Architecture of Raster Scan Display; Computer Graphics Software.	<b>5L</b>

2.	<b>Scan Conversion:</b> Line Drawing Algorithms: DDA, Bresenham's Algorithm; Circle Generation Algorithm: Midpoint, Bresenham's Algorithm; Midpoint Ellipse Generation Algorithm; Aliasing, Antialiasing;	7L
3.	<b>Polygon and Filling algorithms:</b> Inside & Outside Test of Polygon: Odd-Even Method, Winding Number Method; Polygon Filling Algorithms: Scan Line Polygon Fill, Scan Line Seed Fill, Boundary Fill, Flood Fill Algorithm.	5L
4.	<b>2D Transformation:</b> Basic Transformations: Translation, Rotation, Scaling, Reflection, Shear; Transformation Between Coordinate Systems; Homogeneous Coordinates & Combined Transformations; Inverse Transformation: Rotation About An Arbitrary Point, General Fixed Point Scaling, Reflection Through An Arbitrary Line.	5L
5.	<b>Viewing and Clipping:</b> Viewing Transformation: Viewing Pipeline, Window To Viewport Co-Ordinate Transformation; Clipping: Point Clipping, Line Clipping -- Cohen-Sutherland and Liang-Barsky Algorithm; Polygon Clipping -- Sutherland-Hodgeman and Weiler-Atherton Algorithm; Text Clipping.	5L
6.	<b>3D Transformation and Projection:</b> 3D Transformations: Translation, Rotation, Scaling; 3D Projection: Parallel and Perspective Projection, Vanishing Points;	4L
7.	<b>Curves:</b> Curve Generation Algorithm: DDA Method, Approximation Method, Spline Representation, Piecewise Cubic Spline, Bezier Curves – Cubic Bezier, Mid-Point Bezier, B-Spline Curves.	4L
8.	<b>Hidden Surfaces:</b> Depth Comparison, Z-Buffer Algorithm, Back Faces Detection, BSP Tree Method, Painter's Algorithm, Scan-Line Algorithm; Hidden Line Elimination Method, Wire Frame Methods.	4L
9.	<b>Color &amp; Shading Models:</b> Introduction, Modeling Light Intensities and Sources, Diffuse Reflection, Lambert's Cosine Law, Specular Reflection, Half-Toning, Color Models - RGB Color, CMY Color.	3L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Computer Graphics (C version), D. Hearn and M. P. Baker, Prentice Hall.
2. Schaum's Outlines Computer Graphics, Z. Xiang and R. A. Plastock, McGraw Hill.
3. Mathematical Elements for Computer Graphics, D. F. Rogers and J. A. Adams, McGraw Hill.
4. Fundamentals of Computer Graphics & Multimedia, D. P. Mukherjee, Prentice Hall.
5. Computer Graphics: A Programming Approach, S. Harrington, McGraw Hill.
6. Computer Graphics Principles and Practice, A. V. Dam; F. H. John; J. D. Foley; S. K. Feiner, Pearson Education.

7. Principles of Interactive Computer Graphics, W. M. Newman and R. F. Sproull, McGraw Hill.
8. Introduction to Computer Graphics and Multimedia, A. Mukhopadhyay and A. Chattopadhyay, Vikas Publishing House

### Course Outcomes:

Students should demonstrate the ability to:

- Explain the concept of pixel and image; their representation, display and storage.
- Apply different algorithms to draw simple figures like line, circle etc. and fill the inside of a polygon.
- Employ the concept of different transformations, Clipping on two and three dimensional figures.
- Apply different algorithms to generate curve, remove the hidden surfaces for object representation and understand different color models.

Course code	PEC-CSE 611(c)				
Category	Professional Elective Course (PEC)				
Course title	Distributed Systems				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 403, PCC-CSE 501				

### Objectives of the course:

Throughout the course, students will be expected to demonstrate their understanding of Distributed Systems by being able to do the following:

- Develop an understanding of the basic concept of distributed system, architecture of distributed system, distributed object models, communication between distributed system, the concept of synchronization, migration, fault tolerance, agreement, distributed transaction, mobile agent framework and distributed coordination-based systems.

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction to Distributed System:</b> GOALS: Making Resources Accessible, Distribution Transparency, Openness, Scalability, Pitfalls, Types Of Distributed Systems-distributed Computing Systems, Distributed Information Systems, Distributed Pervasive Systems, System Architectures-centralized Architectures, Decentralized Architectures, and Hybrid Architectures.	<b>10L</b>

	<b>Process Concepts:</b> Processes, Threads in Distributed Systems. <b>Middleware:</b> Architectures Versus Middleware-Interceptors, General Approaches to Adaptive Software, CLIENTS-Networked User Interfaces, Client-Side Software for Distribution Transparency, SERVERS-General Design Issues, Server Clusters, Managing Server Clusters, Virtualization.	
2.	<b>Clock Synchronization:</b> Physical Clocks, Global Positioning System, Clock Synchronization Algorithms, LOGICAL CLOCKS, Lamport's Logical Clocks Vector Clocks, Centralized and Decentralized Algorithms. <b>Code Migration:</b> Approaches to Code Migration, Migration and Local Resources, Migration in Heterogeneous Systems, Application of Code Migration using Agent.	12L
3.	<b>Introduction To Fault Tolerance:</b> Basic Concepts, Failure Models, Failure Masking by Redundancy PROCESS RESILIENCE-Design Issues, Failure Masking and Replication Agreement in Faulty Systems Failure Detection DISTRIBUTED COMMIT-Two-Phase Commit, Three-Phase Commit. <b>Java RMI &amp; Mobile Agent:</b> Client side, Server Side, object registry, Remote Interface, Server side software, client side software, Client callback, stub downloading. Basic architecture of Mobile Agent, advantages, mobile agent framework systems, design, implementation using Java RMI.	12L
4.	<b>Distributed coordination-based systems JINI:</b> Runtime Environment, Architecture, Discovery Protocol, Join Protocol, Lookup Service, Distributed Event, Distributed Leasing, Transactions, Surrogate Architecture. <b>Case Study:</b> GARUDA Project, WLHC Grid.	8L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. "Distributed Computing: Principles and Applications", M. L. Liu, Pearson Education.
2. "Distributed Systems-Principles and Paradigms", S. Tanenbum and M. V. Steen, PHI.
3. "Distributed Systems, Concepts and Design", G. Coulouris , J. Dollimore and T. Kindbirg, Pearson Education.
4. "Java.rmi: The Remote Method Invocation Guide", K. McNiff and E. Pitt, Addison-Wesley Professional.
5. "Java RMI: Remote Method Invocation", T. B. Downing, Wiley.
6. "Core JINI", W. K. Edwards, Prentice Hall Ptr.

**Course Outcomes:** On completion of the syllabus, students will be able to:

- Understand the challenges faced while designing distributed systems.
- Conceptualize the architectural, fundamental and security model of distributed systems.

- Synchronize clocks and apply code migration approaches.
- Implement agents using Remote method Invocation, Remote Procedure Call and Event Notification techniques.
- Analyze the reason behind failure and apply Distributed Commit for achieving fault tolerance.
- Develop protocols for a Distributed Coordination-based system.

Course code	PEC-CSE 611(d)				
Category	Professional Elective Course (PEC)				
Course title	Embedded Systems				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 402, PCC-CSE 403				

**Objectives of the course:** To expose the students to the following

- Components of Embedded System Hardware
- Embedded Operating Systems and Middleware
- Features of Hardware - Software Co-Designs
- Different Validation techniques
- Applications of Embedded Systems

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Embedded System Hardware:</b> <ul style="list-style-type: none"> <li>• <b>Input</b> – Sensors, Sample &amp; Hold Circuits, A/D Converters</li> <li>• <b>Communication</b> – Requirements, Electrical Robustness, Guaranteeing Real-Time Behavior</li> <li>• <b>Processing units</b> – Application Specific Integrated Circuits (ASIC), Processors, Reconfigurable Logic</li> <li>• <b>Memory</b> – Scratch Pad Memories (SPM)</li> <li>• <b>Output</b> – D/A Converters, Actuators</li> </ul>	<b>10L</b>
<b>2.</b>	<b>Embedded operating system, Middleware &amp; Scheduling:</b> <ul style="list-style-type: none"> <li>• <b>Prediction of Execution Time</b> – The Worst Case Execution Time (WCET)</li> <li>• <b>Scheduling in Real Time Systems</b> – Classification of Scheduling Algorithms, Aperiodic and Periodic Scheduling, Resource Access Protocols</li> <li>• <b>Embedded Operating Systems</b> – General Requirements, Real Time Operating Systems (RTOS)</li> <li>• <b>Middleware</b> – Real Time Database, Access to Remote Objects</li> </ul>	<b>10L</b>

<b>3.</b>	<b>Implementing Embedded Systems : Hardware Software Co-Design</b> <ul style="list-style-type: none"> <li>• Task level Concurrency Management</li> <li>• High Level Optimization</li> <li>• Hardware / Software Partitioning</li> <li>• Compilers for Embedded Systems</li> <li>• Voltage Scaling and Power Management</li> </ul>	<b>10L</b>
<b>4.</b>	<b>Validation:</b> Simulation, emulation, test, fault simulation, injection, formal verification <b>Applications of Embedded system:</b> Application areas, Growing importance	<b>12L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text** and/or **Reference:**

1. “Embedded system design” by Peter Marwedel, Springer.
2. “Embedded systems” by Barret, Pearson Education.
3. “Embedded system Design – A unified hardware/software introduction” by F. Vahid, T. Ginergies, John Wiley & Sons.

#### Course Outcomes:

- Being acquainted with the components of Embedded Systems hardware.
- Understanding the Properties Embedded Operating Systems.
- Implementing Embedded Systems by Hardware Software Co-Design.
- Testing of Embedded Systems.
- Illustrations application areas of Embedded Systems.

Course code	PEC-CSE 612(a)				
Category	Professional Elective Course (PEC)				
Course title	Advanced Operating Systems				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 403				

#### Objectives of the course:

The aim of this module is to study, learn, and understand the main concepts of advanced operating systems (distributed systems, real time systems etc); Hardware and software features that support these systems.



**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction</b> Review of centralized operating systems, Network and Distributed operating systems, Hardware concepts, Software concepts and design issues.	<b>6L</b>
<b>2.</b>	<b>Synchronization</b> Synchronization in distributed systems, Concept of clock, event ordering, Leader election algorithms, Distributed mutual exclusion algorithms for different topologies etc.	<b>10L</b>
<b>3.</b>	<b>Global state Detection</b> Global state reordering algorithms, Cuts of a distributed computation, termination detection	<b>8L</b>
<b>4.</b>	<b>Deadlock</b> Deadlock detection in distributed systems, centralized algorithms, Distributed algorithms.	<b>6L</b>
<b>5.</b>	<b>Failure Recovery</b> Failure recovery and fault tolerance: classification of failures, Checkpoints, Synchronous check pointing and recovery, Asynchronous check pointing and recovery, Commit protocols, Voting protocols.	<b>8L</b>
<b>6.</b>	<b>Introduction To Real Time System</b> Introduction to real time systems and it's characteristics, basic issues, modeling timing constraint etc.	<b>4L</b>
	<b>TOTAL:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Operating System Concepts Essentials, 9th Edition by Avi Silberschatz, Peter galvin, Greg Gagne, Wiley Asia Student Edition.
2. Advanced Concepts in operating Systems - Mukesh Singhal and Niranjana G. Shivaratri, TMH
3. Distributed Algorithms –NancyLynch, Morgan Kaufmann
4. Introduction to Distributed Algorithms-Gerard Tel, Cambridge University Press
5. Distributed Operating System:Concept of Design-P.K.Sinha, PHI
6. Real-Time Systems: Theory and Practice-Rajib Mal, Pearson Education India

**Course Outcomes:**

- Knowledge and understanding -Outline the potential benefits of distributed systems - Summarize the major security issues associated with distributed systems along with the range of techniques available for increasing system security

- Cognitive skills (thinking and analysis). -Apply standard design principles in the construction of these systems -Select appropriate approaches for building a range of distributed systems, including some that employ middleware

Course Code	PEC-CSE 612 (b)				
Category	Professional Elective Course (PEC)				
Course Title	Soft Computing				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-Requisites (if any)	BSC-M102, BSC-M 202, PCC-CSE 404 and PEC-CSE 611 (a)				

#### Objectives of the Course:

- To provide comprehensive introduction about pitfalls of Artificial Intelligence and emergence of new paradigm like Soft Computing.
- To introduce students to the basic concepts and techniques of granular computing, neuro-computing, evolutionary computing.
- To become familiar with artificial neural network, learning algorithms, fuzzy sets, fuzzy logic principles and relations, genetic algorithm.
- To become familiar with hybrid system usage, application and optimization.
- To develop skills of using recent software for solving practical problems of Soft Computing.

#### Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Hard Computing – Definition, Features and Examples; Soft Computing – Definition, Features and Examples; Fundamental Elements of Soft Computing; Hybrid Computing.	<b>3L</b>
<b>2.</b>	<b>Artificial Neural Network :</b> Basic Concepts of Neural Net; Property of Neural Net; Structure of a Neuron; Model of an Artificial Neuron; Activation Functions; Neural Network Architectures; Learning Methods: Supervised, Unsupervised, Reinforced, Gradient Descent, Competitive, Hebbian, Stochastic.	<b>3L</b>
<b>3.</b>	<b>Models of Artificial Neural Network :</b> Architecture, Features, Training Algorithm and Applications of Mc-Culloch–Pitts Neuron, Perceptron, Adaline, Madaline Network, Hebb Network, Back Propagation Neural Network, Discrete Hopfield Network, Bidirectional Associative Memory, Kohonen Self Organizing Map Model;	<b>12L</b>

<b>4.</b>	<b>Fuzzy Sets and Logic :</b> Crisp Set vs. Fuzzy set; Fuzzy Set- Definition, Membership Function; Discrete and Continuous Fuzzy set; Typical Fuzzy Membership Functions; Features, Transformations, Standard Operations, Properties, Measures, Inaccuracy, Extension Principle of Fuzzy Sets; Fuzzy Relations; Fuzzy Linguistic Variables; Fuzzy Rules; Fuzzy Logic: Typical Propositional Inference Rules; Fuzzy Logic Controller: Mamdani Approach, Working Cycle, Different Methods of De-Fuzzification, Takagi and Sugeno's Approach, Applications;	<b>12L</b>
<b>5.</b>	<b>Genetic Algorithm:</b> Basic Concepts; Advantages and Limitations of GAs; Working Principle; Basic Terminologies: Population, Chromosomes, Genotype, Phenotype, Decoding and Encoding, Fitness Function, Genetic Operators; Basic Structure; Population Initialization and Models; Fitness Function; Parent Selection methods; Crossover and Mutation Operators; Elitism; Termination Condition in GA; Constrained Optimization and Multi-Objective Optimization in GA; Pareto-optimal Front; GA Based Clustering and Pattern Recognition Algorithm;	<b>12L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis & Applications--S. Rajasekharan & G. A. Vijayalakshmi Pai, PHI
2. Neural Networks-- Fausett, Pearson.
3. Soft Computing Fundamentals and Applications – Dilip K. Pratihar, Narosa.
4. Computational Intelligence Principles, Techniques and Applications, Amit Konar, Springer.
5. Neural Networks & Fuzzy Systems- A Dynamical System Approach to Machine Intelligence-- Bart Kosko, PHI.
6. Fuzzy Sets & Fuzzy Logic- Theory & Applications--Klir & Yuan, PHI.
7. Fuzzy Logic- Intelligence, Control & Information-- Yen & Langani, Pearson.
8. Neural Networks- A Comprehensive Foundation-- Simon Haykin, Pearson.
9. Pattern Recognition Principles--Tou & Gonzalez, Addison Wesley.
10. Pattern Classification-- Duda, Hart, Stork, John Wiley & Sons, 2001.
11. Genetic Algorithm in Search, Optimization & Machine Learning-- D.E. Goldberg, Pearson Edu., 2003.

**Course Outcomes:**

Students should demonstrate the ability to:

- Understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications.
- Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic control and other applications of fuzzy logic.
- Understand the basics of an evolutionary computing paradigm known as genetic algorithms and its application to engineering optimization problems.
- Explain the concepts and meta-cognitive of soft computing.
- Apply techniques to solve character recognition, pattern classification, regression and similar problems.

Course code	PEC-CSE 612(c)				
Category	Professional Elective Course (PEC)				
Course title	Digital Signal Processing				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	ESC-EC 501				

### Objectives of the course:

To expose the students to the following:

- Discrete time signals and systems
- Z-transforms and Inverse Z-transforms
- Discrete Fourier Transforms and Fast Fourier Transforms
- Design of various kinds of Digital filters.

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Discrete-time signals and systems:</b> Representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	<b>10L</b>
<b>2.</b>	<b>Z-transform:</b> Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of Z-transform for causal signals, Interpretation of stability in Z-domain, Inverse Z-transforms.	<b>10L</b>
<b>3.</b>	<b>Discrete Fourier Transform:</b> Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.	<b>10L</b>
<b>4.</b>	<b>Design of Digital filters:</b> Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.	<b>12L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. “Digital Signal Processing: A computer based approach” by S. K. Mitra, McGraw Hill.
2. “Discrete Time Signal Processing” by A.V. Oppenheim and R. W. Schaffer, Prentice Hall, 1989.
3. “Digital Signal Processing: Principles, Algorithms And Applications” by J. G. Proakis and D.G. Manolakis, Prentice Hall, 1997.
4. “Theory and Application of Digital Signal Processing” by L. R. Rabiner and B. Gold, Prentice Hall.
5. “Introduction to Digital Signal Processing” by J. R. Johnson, Prentice Hall.
6. “Digital Signal Processing” by D. J. DeFatta, J. G. Lucas and W. S. Hodgkiss, John Wiley & Sons.

**Course Outcomes:**

At the end of this course, students will demonstrate the ability to

- Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
- Analyze discrete-time systems using z-transform.
- Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
- Design digital filters for various applications.
- Apply digital signal processing for the analysis of real-life signals.

Course code	PEC-CSE 612(d)				
Category	Professional Elective Course (PEC)				
Course title	Data Mining				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	PCC CSE 301, PCC CSE 501				

**Objectives of the course:**

Throughout the course students will be able to:

- Understand the data mining fundamental concepts and techniques from multiple perspectives.
- Advance relevant programming skills.
- Develop skills and apply data mining tools for solving practical problems
- To perform preprocessing, classification, association, and prediction of data

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction to Data Mining:</b> Process of Knowledge Discovery, Types of Data, Data Mining Functionalities. Data Objects and Attribute Types, Measuring Data Similarity and Dissimilarity, Data Visualization Techniques, Major issues in data mining.	<b>5L</b>
<b>2.</b>	<b>Data pre-processing:</b> Data summarization, Data cleaning, Data integration and transformation, Data reduction techniques, Data discretization and concept hierarchy generalization. Basic concepts of Outliers, Outlier Detection Methods.	<b>6L</b>
<b>3.</b>	<b>Association Rule Mining:</b> Frequent Itemset Mining methods – Apriori Algorithm, FP-Tree Growth. Association Rules & their types, Association to Correlation	<b>7L</b>
<b>4.</b>	<b>Classification and Prediction:</b> Decision trees, Bayesian Classifier, Rule-Based Classification, kNearest-Neighbor Classifiers, Associative Classifier, Model Evaluation-Cross-Validation, Comparing Classifiers Based on Cost– Benefit and ROC Curves.	<b>7L</b>
<b>5.</b>	<b>Cluster Analysis:</b> Categories of Clustering Methods: Partitioning, Hierarchical, Density based, Grid-based methods, Clustering of High-Dimensional Data, Evaluation of Clustering-Measuring Clustering Quality	<b>6L</b>
<b>6.</b>	<b>Data warehouse:</b> Data warehouse definition, multidimensional data model(s), data warehouse architecture, OLAP server types, data warehouse implementation, on-line analytical processing and mining,	<b>5L</b>
<b>7.</b>	<b>Data mining on complex data and applications:</b> Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining.	<b>6L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Han, J. and Kamber, M., “Data Mining - Concepts and Techniques”, 3rd Ed., Morgan Kaufmann Series.
2. Ali, A. B. M. S. and Wasimi, S. A., “Data Mining - Methods and Techniques”, Cengage Publishers.
3. Tan, P.N., Steinbach, M. and Kumar, V., “Introduction to Data Mining”, Addison Wesley – Pearson
4. Pujari, A. K., “Data Mining Techniques”, 4th Ed., Sangam Books.

**Course Outcomes:**

After undergoing the course students will be able to:

- Synthesize the data mining fundamental concepts and techniques from multiple perspectives.
- Develop skills and apply data mining tools for solving practical problems.
- Advance relevant programming skills.
- Gain experience and develop research skills by reading the data mining literature.

Course code	HSM-HU 681 (For Laboratory)				
Category	Humanities Science & Management (HSM)				
Course title	Group Discussion & Personal Interview				
Scheme and Credits	L	T	P	Credit	Semester – VI
	0	0	2	1	
Pre-requisites (if any)	Basic knowledge of oral & technical communication				

**Laboratory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Practical Period</b>
<b>1.</b>	<b>Advanced Techniques in Technical Communication:</b> using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media	<b>5P</b>
<b>2.</b>	<b>Presentation:</b> Techniques of effective presentations by using various audiovisual aids	<b>5P</b>
<b>3.</b>	<b>Interview:</b> Methods and Etiquettes; practice of mock interview; interview through telephone/video-conferencing	<b>8P</b>
<b>4.</b>	<b>Group Discussion:</b> Model group discussion through the choice of appropriate programmers	<b>7P</b>
<b>5</b>	<b>Interaction with experts</b>	<b>3P</b>
	<b>Total:</b>	<b>28P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. How to Prepare for Group Discussion & Interview. Hari Mohan Prasad, Rajnish Mohan. Tata McGraw Hill Education, New Delhi: 2012.
2. Mastering Interviews and Group Discussions. Dinesh Mathur. CBS Publication, New Delhi: 2017.
3. Technical Interviews: Excel with Ease. Anil Kumar Maini. Pearson, Chennai: 2011.
4. Group Discussions and Interviews. Anand Ganguly. RPH, New Delhi: 2014.
5. The Interview Book: Your Definite Guide to the Perfect Interview Technique. James Innes. Prentice Hall Business, New Jersey: 2009.

**Course Outcomes:**

On completion of the course students will be to:

- Learn structure and format for effective communications, using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media
- Deliver effective power-point presentation.
- Take part in Interview through telephone/video-conferencing.
- Become proficient to face interviews and model group discussions.

Course code	PROJ-CSE 691				
Category	Project				
Course title	Project-I				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	6	3	
Pre-requisites (if any)	As per the technical requirements of the Project, the concerned Project Guide may prepare the pre-requisites				

- The department should form project groups each comprising of few Students (depending on total batch strength and number of faculty members) where, each of these project groups shall be under the guidance of a faculty member. They need to complete the project work spanning through 3 semesters (Semester VI, VII & VIII). Project-I is the first part covered in Semester-VI.
- Students must maintain regularity in their project work.
- Students shall try to acquire thorough knowledge on the topics as guided by the concerned faculty member. Each project groups may conduct literature surveys on the said topics. At the end of Semester-VI students have to submit an Initial Project Report comprising on findings of the literature survey and a synopsis of their proposed work. Each group should submit at least two extra copy of Initial Project Report other than their individual copy, one for their Project guide and one for the departmental record.



**Semester VII (Fourth year) Curriculum**  
**Branch/Course: Computer Science and Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course	PEC-CSE IV	Professional Elective IV	3	0	0	3	100
2	Professional Elective Course	PEC-CSE V	Professional Elective V	3	0	0	3	100
3	Open Elective Course	OEC-X 721 <sup>#</sup>	Open Elective II	3	0	0	3	100
4	Humanities & Social Sciences including Management Course	HSM-HU 702	Values and Ethics	2	0	0	2	100
5	Project	PROJ-CSE 791	Project-II	0	0	12	6	100
6	Project	PROJ-INT 791	Internship	0	0	\$	2	100
<b>Total:</b>							<b>19</b>	<b>600</b>

PEC-CSE IV		PEC-CSE V	
Paper Code	Paper Name	Paper Code	Paper Name
PEC-CSE 711(a)	Computational Geometry	PEC-CSE 712(a)	VLSI System Design
PEC-CSE 711(b)	Multi-agent Intelligent Systems	PEC-CSE 712(b)	Data Analytics
PEC-CSE 711(c)	Image Processing	PEC-CSE 712(c)	Optimization Techniques
PEC-CSE 711(d)	Web and Internet Technology	PEC-CSE 712(d)	Cloud Computing

# Here X denotes the code of the offering departments such as HU/EC/EI/M. Refer to Appendix-I

\$ An Internship of 40 hours per week to be done after 2<sup>nd</sup> / 4<sup>th</sup> / 6<sup>th</sup> semester examination (during semester gap)

Course code	PEC-CSE 711(a) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Computational Geometry				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 301, PCC-CSE 404				

**Objectives of the course:** Throughout the course students will be able to:

- Grasp the fundamental concept in computational geometry.
- Strengthen students' ability to use geometric structures and techniques to solve difficult problems.
- Understand the rigorous algorithmic analysis for problems in Computational Geometry.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Computational Geometry Introduction:</b> Historical perspectives, Geometric preliminaries, Definitions of Convexity and Convex Hulls, Orientation test, Degeneracy, Naive Algorithms for Extreme Points, Gift Wrapping, Jarvis' March, Divide & conquer; Graham's scan, Chan's algorithm, Lower bound analysis for Convex Hull Algorithm.	<b>5L</b>
<b>2.</b>	<b>Search and Intersection:</b> Line Segment Intersection, Doubly Linked Edge List, Overlay Subdivisions, Point Location And Trapezoidal Maps, A Randomized Incremental Algorithm, Planar Point Location, Point In Polyhedron, Intersection of Convex Polygons, Intersection of Non convex Polygons, Extreme Point of Convex Polygon.	<b>8L</b>
<b>3.</b>	<b>Polygon Triangulation and Partitioning:</b> Triangulation Theory, Area Of Polygon, Segment Intersection, Segment-Triangle Intersection. Art Gallery Theorem, Monotone Partitioning, Trapezoidalization, Partition Into Monotone Mountains, Linear-Time Triangulation, Convex Partitioning.	<b>7L</b>
<b>4.</b>	<b>Orthogonal Search:</b> Geometric Data Structures; Range Search (Quad-Tree, Kd-Tree), Improvements on Range Searching (Range Tree, Fractional Cascading), Inverse Range Search (Segment Tree, Interval Tree, Priority Search Tree)	<b>7L</b>
<b>5.</b>	<b>Voronoi Diagram and Delaunay Triangulation:</b> Definition and Basic Properties of Voronoi Diagram, Fortune Sweep Algorithm, Divide and Conquer Algorithm. Closest pair Problems. Application of Voronoi Diagrams, Triangulations of Planar Point Sets, The Delaunay Triangulation, Computing the Delaunay Triangulation.	<b>6L</b>
<b>6.</b>	<b>Arrangements:</b> Combinatorics of Arrangements, Incremental Algorithm, Three and Higher Dimensions, Duality, Higher-Order Voronoi Diagrams, Applications	<b>4L</b>

7.	<b>Motion Planning:</b> Shortest Paths, Moving a Disk, Translating a Convex Polygon, Moving a Ladder, Robot Arm Motion, Separability	<b>5L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Franco P. Preparata and Michael Ian Shamos, Computational Geometry- An Introduction, Springer Verlag.
2. Mark de Berg, Marc van Kreveld, Mark Overmars, Otfried Cheong, Computational Geometry: Algorithms and Applications, Third Edition, Springer Verlag.
3. Joseph O' Rourke, Computational Geometry in C, Cambridge University Press.
4. B. Casselman, Mathematical Illustrations: A Manual of Geometry and PostScript, Springer-Verlag.

**Course Outcomes:** After undergoing the course students will be able to:

- Acquire a basic concept of the algorithmic techniques of computational geometry.
- Implement new geometric algorithms.
- Analyze algorithm for some geometric problems.
- Apply geometric techniques to real-world problems in graphics.

Course code	PEC-CSE 711(b)				
Category	Professional Elective Course (PEC)				
Course title	Multi-agent Intelligent Systems				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 201, PCC-CSE 301, PEC-CSE 611(a)				

**Course Objectives:**

To expose the students to the following:

- Agents, Multi Agent systems and what are their characteristics, reasoning about agents' knowledge and beliefs.
- Distributed planning, high-level communication and automated negotiation, coordination mechanisms
- MAS learning, organizational issues, and multi-agent systems architectures involved in building closed or open distributed systems.
- Applications of agent technology
- Different agent paradigm and specific architecture or system for solving particular problem.

## Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1	<b>Introduction:</b> Environments of Agents, Intelligent Agents, Agents and Objects, Agents and Expert Systems, Agents as Intentional Systems, Abstract Architectures for Intelligent Agents.	4L
2	<b>Deductive Reasoning Agents:</b> Agent Architectures, Symbolic Reasoning Agents, Deductive Reasoning Agents, Planning systems, METATEM and Concurrent METATEM.	4L
3	<b>Practical Reasoning:</b> Intentions in Practical Reasoning, Planning agents (again), Means-end reasoning, STRIPS, Deliberation, BDI Theory and Practice, Implemented BDI Agents, HOMER.	8L
4	<b>Reactive and Hybrid Architectures:</b> Brooks – behaviour languages, . Steels’ Mars Explorer, Situated Automata, Advantages of Reactive Agents, Limitations of Reactive Agents, Hybrid Architectures.	4L
5	<b>Multi-agent Interactions:</b> Utilities and Preferences, Multi-agent Encounters, Dominant Strategies and Nash Equilibrium, Competitive and Zero-Sum Interactions, The Prisoner's Dilemma, Other Symmetric 2 x 2 Interactions, Dependence Relations in Multi-agent Systems.	4L
6	<b>Reaching Agreements:</b> Mechanism Design, Auctions, Negotiation, Task-oriented domains, Worth-oriented domains, Argumentation	2L
7	<b>Communication:</b> Speech Acts, Agent Communication Languages, Ontologies for Agent Communication, Coordination Languages	2L
8	<b>Working Together:</b> Cooperative Distributed Problem Solving, Task Sharing and Result Sharing, Task sharing in the Contract Net, Result Sharing, Combining Task and Result Sharing, Handling Inconsistency, Coordination, Multi-agent Planning and Synchronization	2L
9	<b>Applications:</b> Mobile Agents, Agents for Workflow and Business Process Management, Agents for Distributed Sensing, Agents for Information Retrieval and Management, Agents for Electronic Commerce, Agents for Human-Computer Interfaces, Agents for Virtual Environments, Agents for Social Simulation, Agents for X	9L
10	<b>Logics for Multi-agent Systems:</b> Modal Logic, Possible Worlds Semantics for Modal Logics, Normal Modal Logics, Epistemic Logic for Multi-agent Systems, Pro-attitudes: Goals and Desires, Common and Distributed knowledge, Integrated Theories of Agency, Formal Methods in Agent-Oriented Software Engineering.	3L
	<b>TOTAL:</b>	42L
	<b>Total Week Required:</b>	14
	<b>No. Of Week Reserved:</b>	02

**Books: Text and/or Reference:**

1. Artificial Intelligence – A Modern Approach, 2nd Edition by Stuart Russell - Peter Norvig, Pearson.
2. An Introduction to Multi-agent Systems by Michael Wooldridge, John Wiley & Sons.
3. Multi-agent Systems: Algorithmic, Game-Theoretic, and Logical Foundations by Yoav Shoham & Kevin Leyton-Brown, Cambridge.
4. Multi-agent Systems, Second Edition, Edited by Gerhard Weiss, Intelligent Robotics and Autonomous Agents series, MIT Press.
5. Multi-agent Systems: An Introduction to Distributed Artificial Intelligence by Jacques Ferber, Addison-Wesley, Pearson.

**Course Outcomes:** On completion of the course students will be able to

- Know what ideas, what new trends and what new possibilities are offered by intelligent agents and MAS.
- Build multi-agent systems or select the right MAS framework for solving a real-world problem based on concepts such as distribution of tasks, communication, cooperation and coordination of actions;
- Use the agent technology in areas such as Internet information gathering, electronic commerce and virtual markets, distributed decision making, workflow management, collaborative scientific work, and integration of legacy systems.
- Learn what the agent paradigm brings as compared to distributed processing or object oriented software development.

Course Code	PEC-CSE 711 (c)				
Category	Professional Elective Course (PEC)				
Course Title	Image Processing				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-Requisites (if any)	BSC-M 102, BSC-M 202, PCC-CSE 302, ESC-EC 501, PEC-CSE 611 (b), PEC-CSE 612 (c)				

**Objectives of the course:**

1. Develop a theoretical foundation of fundamental Digital Image Processing concepts.
2. Provide mathematical foundations for digital manipulation of images; image acquisition; preprocessing; segmentation; Fourier domain processing; and compression.
3. Design and implement algorithms that perform basic image processing (e.g. noise removal and image enhancement).
4. Design and implement algorithms for advanced image analysis (e.g. image compression, image segmentation).
5. Assess the performance of image processing algorithms and systems.

## Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	<p><b>Introduction:</b> Background, Digital Image Representation, Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display.</p> <p><b>Digital Image Formation:</b> A Simple Image Formation Model, Image Sampling &amp; Quantization, Representing Digital Images, Spatial and Gray-Level Resolution, Zooming and Shrinking of Digital Images, Relationships Between Pixels-Neighbors of a Pixel, Adjacency, Connectivity, Regions and Boundaries; Distance Measures.</p>	5L
2.	<p><b>Image Enhancement :</b> <b>Spatial Domain Method:</b> Gray level Transformations, Contrast Enhancement- Linear &amp; Nonlinear Stretching; Histogram Processing; Enhancement using Arithmetic / Logic Operations; Smoothing - Image Averaging, Order-Statistics Filters; Sharpening –Derivative Filtering, Unsharp Masking, High-boost Filtering.</p> <p><b>Frequency Domain Method:</b> Mathematical Preliminaries - Fourier Transformation, Properties of The Two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine, and Wavelet Transform. Basics of Filtering in Frequency Domain, Smoothing - Low Pass filters; Sharpening - High pass filters, Laplacian Filter, Unsharp Masking, High Boost Filtering, Homomorphic Filtering.</p>	10L
3.	<p><b>Image Restoration:</b> Degradation Model, Noise Probability Density Functions, Spatial Noise Filters, Frequency Domain Noise Filters, Estimating Degradation function, Minimum Mean Square Error and Constrained Least Square Filtering, Geometric Transformation - Spatial Transformation, Gray Level Interpolation.</p>	6L
4.	<p><b>Image Segmentation:</b> Point Detection, Line Detection, Edge detection, Edge Linking &amp; Boundary Detection- Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding; Region Based Segmentation - Basic Formulation, Region Growing, Region Splitting &amp; Merging.</p>	6L
5.	<p><b>Image Representation and Description:</b> Representation schemes, Chain codes, Polygonal approximations, Signatures, Boundary Segments, Skeletons; Boundary Descriptors – Simple, Shape Numbers and Fourier; Regional Descriptors – Topological and Texture.</p>	5L
6.	<p><b>Image Compression:</b> Redundancy Removal Techniques, Image Compression Models, Elements of Information Theory, Error-Free Compression - Huffman Coding, Arithmetic Coding.</p>	5L

7.	<b>Morphological Image Processing:</b> Introduction, Dilation and Erosion, Opening and Closing Operations, Hit-or-Miss Transformation, Boundary Extraction, Thinning, Thickening, Skeletons, Pruning.	<b>5L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Digital Image Processing, Gonzalez and Woods, Pearson Education
2. Digital Image Processing, Jahne, Springer India
3. Digital Image Processing and Analysis, Chanda & Majumder, PHI
4. Fundamentals of Digital Image Processing, Jain, PHI
5. Fundamentals of Digital Image Processing, S. Annadurai, Pearson Education

**Course Outcomes:** Students should demonstrate the ability to:

1. Explain how digital images are represented and the principals of the Digital Image Processing terminology used to describe features of images.
2. Examine various types of images, intensity transformations and understand the mathematical foundations for digital manipulation of images; image acquisition; preprocessing; segmentation; Fourier domain processing.
3. Learn different causes for image degradation and overview of image restoration techniques.
4. Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.
5. Analyze a wide range of problems and provide solutions related to the design of image processing systems through suitable algorithms, structures, diagrams, and other appropriate methods.

Course code	PEC-CSE 711(d) (For Theory)				
Category	Professional Elective Course (PCC)				
Course title	Web and Internet Technology (Theory)				
Scheme and	L	T	P	Credits	Semester – VII
Credits	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 503, PCC-CSE 553, PCC-CSE 602, PCC-CSE 652				

**Objectives of the course:**

1. To give the overview of Internet and Mobile IP
2. To design and create web pages using HTML and CSS.
3. To Create web pages and provide client side validation.
4. To create dynamic web pages using server side scripting.
5. To use MVC framework for web application development.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>An Overview on Internet</b> Need for an Internet, Evolution of Internet, Concept of Internet, Intranet and Extranet, URI, URL, URN, Concept of Search Engine, Search Engine Optimization, Types of Search Engine, Search Engine Optimization Algorithms.	<b>5L</b>
<b>2.</b>	<b>Mobile IP:</b> Definition of Mobile IP, Stationary Hosts, Mobile Host, Three Phases of Remote host to Mobile Host Communication, Inefficiency of Mobile IP, Double Crossing, Triangle Routing.	<b>5L</b>
<b>3.</b>	<b>Introduction to Web:</b> Web Architecture, Web Applications, Web servers, Web Browsers, Internet standards.	<b>2L</b>
<b>4.</b>	<b>Hyper Text Markup Language:</b> Elements, Attributes, Tags, Tables, Forms, Frames.	<b>3L</b>
<b>5.</b>	<b>Cascading Style Sheets:</b> Advantages, Rules, CSS and page Layout	<b>2L</b>
<b>6.</b>	<b>JavaScript and DHTML:</b> Regular Expression, Event Handling, W3C Event Handling Model, HTML DOM, JavaScript and HTML DOM, JavaScript and HTML Forms, AJAX.	<b>5L</b>
<b>7.</b>	<b>Applets:</b> Client-side Java, Life Cycle, Writing an Applet, Compiling an Applet, The Applet Tag, Security, Utility Methods, Using Status Bar, Applet Context Interface, Document Base and Code Base, Passing Parameter, Event Handling, Communication between Two Applets, Loading Web Pages.	<b>5L</b>
<b>8.</b>	<b>Server-side Programming:</b> Common Gateway Interface (CGI)—Internet Programming paradigm, languages for CGI, Applications, Server Environment, Environment Variables, CGI Building Blocks, CGI Scripting Using C, Shell Script, Writing CGI Programs, CGI Security, Alternatives and Enhancements to CGI	<b>5L</b>



9.	<b>Servlets:</b> Server-side Java, Advantages Over Applets, Alternatives, Strengths, Architecture, Life Cycle, Generic Servlet and Http Servlet, Passing and Retrieving Parameters, Server-Side Include, Cookies, Filters, Problems with Servlet, Security Issues	<b>5L</b>
10.	<b>Java Server Pages:</b> JSP and HTTP, JSP Engines, How JSP Works, JSP and Servlet, Anatomy of a JSP Page, JSP Syntax, JSP Components, Beans, Session Tracking, Users Passing Control and Data between Pages, Sharing Session and Application Data, Database Connectivity, JDBC Drivers, Basic Steps, Loading a Driver, Making a Connection, Execute an SQL Statement, SQL Statements, Retrieving Result, Getting Database Information, Scrollable and Updatable Result Set, Result Set Metadata	<b>5L</b>
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. B. A. Forouzan, TCP/IP Protocol Suite, McGraw Hill Higher Education
2. D. Minoli, Internet & Intranet Engineering, McGraw-Hill Education (India) Pvt Limited
3. E. Enge ,S. Spencer, J.Stricchiola, R. Fishkin, The Art of SEO: Mastering Search Engine Optimization, O'REILLY
4. Web Technologies HTML, Javascript, PHP, Java, JSP,ASP.NET, XML and AJAX BLACK book, Dreamtech Press
5. D. Goodman, Dynamic HTML: The Definitive Reference, O'REILLY
6. D. Flanagan, JavaScript: The Definitive Guide, O'REILLY
7. E. R. Harold, W. S. Means, XML in a Nutshell: A Desktop Quick Reference, O'REILLY
8. A. Moller, M. Schwartzbach, An Introduction to XML and Web Technologies, Pearson Education India
9. H. Bergsten, Java Server Pages: Help for Server-Side Java Developers, O'REILLY
10. M. Wutka, Special Edition Using Java Server Pages and Servlets, Que Publishing
11. R. Barton, J. Henry, P. Grossetete, R. Trollope, G. Salgueiro, D. Hanes, IoT Fundamentals : Networking Technologies, Protocols and Use Cases for the Internet of Things, Pearson Education

**Course outcomes:** After taking the course, students will be able to

- Understand the basic of Internet and Mobile IP.
- Understand the core concepts and features of Web Technology
- Design static web pages using HTML and CSS
- Apply the concept of client side validation and design dynamic web pages using JavaScript
- Analyze end user requirements and Create web application using appropriate web technologies and web development framework
- Design Server side pages.

Course code	PEC-CSE 712 (a)				
Category	Professional Elective Course (PEC)				
Course title	VLSI System Design				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 302, PCC-CSE 401				

### Objectives of the course:

To expose the students to the following:

- Concepts of physics of MOSFETs
- Static or steady state circuit designs
- Dynamic circuit designs and effects of Parasitic Capacitors
- Steps of IC fabrication
- Power Consumption within CMOS VLSI circuits
- VLSI design cycle and introduction to Physical Design processes

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction to VLSI circuit design:</b> Integrated Circuits, Gordon Moore's Prediction. <b>MOSFETs:</b> Operation of MOS transistors, NMOS, PMOS, Comparisons, Realization of NOT, NAND, NOR gates using PMOS, NMOS transistors. <b>Static Logic design:</b> Static NMOS and CMOS combinational networks, OAI, AOI logic gates, Pseudo NMOS circuits.	<b>10L</b>
<b>2.</b>	<b>Fabrication:</b> Basic IC fabrication steps, NMOS fabrication, N-well CMOS fabrication process. <b>Design Rules:</b> Layout Design Rules, Lambda & Micron Design Rules. <b>Stick Diagram:</b> Layout Stick Diagrams, Example of a MOS. <b>Pass Transistors:</b> Degraded Signal Passing Phenomenon, Transmission Gates. Delays through Pass Gates, Transmission Gates.	<b>10L</b>

<b>3.</b>	<b>Dynamic Logic Design:</b> Dynamic CMOS, Cascading Problem, Domino CMOS structures, Charge Sharing, NORA logic circuit. <b>Power Consumption:</b> Static & Dynamic Power, Switching Activity, Different Power Reduction Techniques of VLSI circuits.	<b>10L</b>
<b>4.</b>	<b>VLSI Design Cycle:</b> System Specification, Design Entry – HDL/ Schematic, Logic Design & Verification, Physical design, Fabrication & Packing. <b>Design Styles:</b> Full Custom, Standard Cell, Gate Arrays, FPGAs, and Comparisons between them. <b>Basic idea of Physical design:</b> Partitioning, Placement, Floor planning, Routing. <b>Routing:</b> Global Routing - Maze routing, Line Probe, Shortest path, Steiner Tree based Algorithms. Detailed Routing - an overview.	<b>12L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. “CMOS Digital Integrated Circuits” by S.M. Kang, Y. Leblebici, Mc Graw Hill.
2. “CMOS VLSI Design” by N.H.E Weste, D.M. Harris, A. Banerjee, Pearson Education.
3. “Principles of CMOS VLSI Design” by K. Eshraghian, N.H.E Weste, Pearson Education.
4. “VLSI Digital Signal Processing” by K. Parhi, IEEE - Wiley Press.
5. “Integrated Electronics” by J. Millman, C. Halkias, Tata Mc Graw Hill.
6. “CMOS Circuit Design Layout and Simulation” by R. J. Baker, IEEE - Wiley Press.
7. “Algorithms for VLSI Physical Design Automation”, Naveed A Sherwani, Kluwer Academic Publishers.

**Course Outcomes:** On completion of the course students will be able to,

- Realize the relevance and significance of Integrated Circuits in today’s world.
- Adapt skills and acumen for designing different kinds of MOS based logic circuits.
- Develop the basic idea of Fabrication.
- Maintain and abide Layout design rules and thereby planning of layout stick diagrams.
- Design VLSI circuits by adapting different power reduction styles.
- Able to test VLSI circuits for increasing reliability.
- Conceptualize algorithms for VLSI routing.
- Visualize the basic hardware fabric of a computing system and physical structure of a computer.

Course code	PEC-CSE 712(b) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Data Analytics				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	BSC-M 202, PCC-CSE 501				

**Objectives of the course:** Throughout the course students will be able to:

- Conceptualization and summarization of data and big data
- Learn, understand, and practice data analytics with different approaches.
- Learn and understand different programming model of big data.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Introduction to Data Analytics, , Sources of structured, semi-structured and unstructured data, Types of Data Analytics: Descriptive Analytics, Diagnostic Analytics, Predictive Analytics, and Prescriptive Analytics. Use Cases, Issues and Challenges in Big Data Analytics.	<b>4L</b>
<b>2.</b>	<b>Fundamentals of Statistics:</b> Descriptive Statistics, Probability Distributions, Inferential Statistics through hypothesis tests	<b>9L</b>
<b>3.</b>	<b>Regression:</b> Introduction to Regression- Ordinary Least Squares, Analysis of Variance, Ridge Regression, Lasso Regression	<b>9L</b>
<b>4.</b>	<b>Regression and Classification techniques:</b> Logistic Regression, Training a Logistic Regression Classifier, Classification and Regression Trees, Bias-Variance Dichotomy, Model Assessment and Selection, Linear Discriminant Analysis, Ensemble Methods: Random Forest	<b>8L</b>
<b>5.</b>	<b>Introduction to Bigdata:</b> Fundamentals of Big Data, Examining Big Data Types, Big Data Technology Components, MapReduce Fundamentals	<b>6L</b>
<b>6.</b>	<b>Big Data Analytics:</b> Defining Big Data Analytics, Big Data Analytics Applications	<b>6L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text** and/or **Reference:**

1. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009.
2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010.
3. Manoochehri, Murthy, Lander, Big Data Analytics, Pearson Education.
4. Dr. Arvind Sathi, Big Data Analytics: Disruptive Technologies for Changing the Game, MC Press.

**Course Outcomes:** After undergoing the course students will be able to:

- Identify the difference between structured, semi-structured and unstructured data.
- Apply different technique to analyze the data
- Summarize the challenges of big data and how to deal with the same.

Course code	PEC-CSE 712(c) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Optimization Techniques				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	BSC-M 102, PCC-CSE 401				

**Objectives of the course:** Throughout the course students will be able to:

- Introduce the fundamental concepts of Optimization Techniques;
- Learn efficient computational procedures to solve optimization problems.
- Acquire the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Introduction, The Basic Optimization Problem, Development, Mathematical Problem Formulation, Engineering Applications of Optimization, Branches of Mathematical Programming.	<b>3L</b>
<b>2.</b>	<b>Optimization Using Calculus</b> - Optimality Criterion For Single And Multi-Variable Method, Region Elimination Methods, Gradient Based Methods For Single Variable And Multivariable, Unidirectional Search, Direct Search Methods, Lagrangian function	<b>6L</b>
<b>3.</b>	<b>Linear Programming</b> - Standard form of linear programming (LP) problem, Simplex algorithm, Simplex criterion, Duality in LP.	<b>9L</b>

4.	<b>Dynamic Programming:</b> A Prototype Example for Dynamic Programming, Characteristics of Dynamic Programming Problems, Deterministic Dynamic Programming, Probabilistic Dynamic Programming..	8L
5.	<b>Integer Programming:</b> Integer linear programming, Concept of cutting plane method, Mixed integer programming, Solution algorithms, Examples	4L
6.	<b>Non-Linear Programming-</b> Introduction, examples of non-linear programming, types of nonlinear programming, Constraint and Unconstrained optimization, methods of nonlinear programming. Convex Optimization Problems	6L
7.	<b>Advanced Topics in Optimization-</b> Genetic Algorithms, Particle Swarm Optimization, Differential Evolution, Multi-objective optimization Applications,	6L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text** and/or **Reference:**

1. S. S. Rao, Engineering Optimization: Theory and Practice, New Age International.
2. K. Deb, Optimization for Engineering Design, Prentice Hall of India.
3. A. Ravindran, K. M. Ragsdell and G. V. Reklaitis, Engineering Optimization: Methods and Applications, Wiley.
4. Hillier & Lieberman, Introduction to Operations Research, TMH.
5. S. M. Sinha, Mathematical Programming, Elsevier.
6. Handy Taha, Operations Research – An Introduction, Prentice Hall of India, New Delhi.
7. R. Fletcher, Practical Methods of Optimization, Wiley.

**Course Outcomes:** After undergoing the course students will be able to:

- Understand the Basic principles of optimization and classical optimization techniques.
- Enumerate fundamentals of Linear Programming and Dynamic Programming Integer programming technique
- Apply different techniques to solve various optimization problems arising from engineering areas.

Course code	PEC-CSE 712(d) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Cloud Computing				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 602				

**Objectives of the course:**

Throughout the course, students will be expected to demonstrate their understanding of Cloud Computing by being able to do each of the following:

- Analyze the basics of cloud computing.
- Understand the architecture, service models.
- Analyze the virtualization along with privacy & security in cloud.
- Know diversified technologies working for cloud architecture for various applications.
- Develop cloud application using simulator.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction to Cloud Computing:</b> Cloud Computing-History, Need for Cloud Computing, Basic Concepts & Terminology, Goals & Benefits, Risks & Challenges, Roles and Boundaries, Cloud Characteristics, Advantages and Disadvantages of Cloud Computing.	<b>8L</b>
<b>2.</b>	<b>Cloud Delivery Models:</b> Concept of Cloud Delivery Models, Infrastructure as a Service, Platform as a Service, Software as a Service, Comparing Cloud Delivery Models, Combining Cloud Delivery Model. <b>Cloud Deployment Models:</b> Concept of Cloud Deployment Models, Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds, Other Models.	<b>12L</b>
<b>3.</b>	<b>Virtualization &amp; Data Center Technology:</b> Concept of Virtualization, Different Types of Virtualizations, Virtualization Management, Overview of Data Center Technology, Multitenant Technology.	<b>10L</b>
<b>4.</b>	<b>Cloud Security &amp; Risk:</b> Different Security Issues in Cloud Environment, Different Types of Threats, Cloud Security Threats, Cloud Security Services, Risks in Cloud Computing, Risk Management. <b>Cloud Computing Tools and Applications:</b> Introduction to Different Cloud Computing Tools (CloudSim, OpenNebula, Nimbus), Case Study on different Cloud Applications (Microsoft Cloud Services, Amazon Cloud Services, Google Cloud Applications), Advanced Cloud Applications (Mobile Cloud, Multimedia Cloud, Green Cloud).	<b>12L</b>
		<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. R. Puttini, T. Erl, and Z. Mahmood, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall
2. M. Miller, Cloud Computing: Web-Based Application That Change the Way You Work and

Collaborate Online, Que Publishing

3. T. Velte, Cloud Computing A Practical Approach, Mcgraw Hill Education

4. A. Srinivasan, J. Suresh, Cloud Computing: A Practical Approach for Learning and Implementation, Pearson

5. A. Bahga, V. Madiseti, Cloud Computing: A Hands-On Approach

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

- Understand and analyze the architecture of Cloud.
- Identify and apply deployment and management options of different Cloud Architecture
- Understand and analyze the security issues in cloud infrastructure.
- Formulate policy based scenarios using Cloud simulators.

<b>Course code</b>	HSM-HU 702				
<b>Category</b>	Humanities and Social Sciences including Management courses				
<b>Course title</b>	<b>Values and Ethics</b>				
<b>Scheme and Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	Semester – VII
	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	
<b>Pre-requisites (if any)</b>	Students are expected to have some basic understanding of moral values and some sense of right or wrong activities with some practical examples which they learn from their childhood and from the family, friends, school, society etc.				

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Nature of professional ethics:-</b> Introduction, definition, morals & ethics sources of ethics, sources of ethics, relationship between ethics and management. Nature of professional ethics, importance of ethics in profession, nature and objectives of ethics, need for ethics.	<b>03L</b>
<b>2.</b>	<b>Engineering Ethics:</b> Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories. Valuing Time – Co-operation – Commitment – Nature of Engineering Ethics, Profession and Professionalism, Professional Ethics, Code of Ethics, Sample Codes – IEEE, ASCE, ASME and CSI.	<b>06L</b>
<b>3.</b>	<b>Effects of technological growth:-</b> Energy Crisis, Rapid technological growth, environmental degradation and pollution, human operator in Engineering projects and industries, problems of man, machine, interaction. Impact of assembly line and automation.	<b>04L</b>



<b>4.</b>	<b>Ethics in profession:-</b> Engineering profession, ethical issues in engineering practice, conflicts between business demands and professional ideals, social and ethical responsibilities of technologists, code of professional Ethics, Whistle blowing and beyond, effects of globalization in modern organization, case study.	<b>05L</b>
<b>5.</b>	<b>Ethical decision making:-</b> Values, morals, standards, corporate social responsibility, attitude and beliefs, ethical values and dimensions dilemmas- decision making, organization and power politics.	<b>05L</b>
<b>6.</b>	<b>Managing ethics:-</b> Building a value system, role of law enforcement, training in ethics, ethics in commercial and operational profession, ethics in finance, ethics in HRM, ethics in Global Business, ethics and IT.	<b>05L</b>
	<b>Total</b>	<b>28L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Blending the best of the East & West, Dr. Subir Chowdhury, EXCEL
2. Ethics & Mgmt. & Indian Ethos, Ghosh, VIKAS
3. Business Ethics, Pherwani, EPH
4. Ethics, Indian Ethos & Mgmt., Balachandran, Raja, Nair, Shroff Publishers
5. Business Ethics: concept and cases, Velasquez, Pearson
6. Engineering Ethics: Charles D. Fiedlermann, Pearson / PHI, New Jersey 2004 (Indian Reprint)
7. Engineering Ethics – Concepts and Cases: Charles E Harris, Michael S. Protchard and Michael J Rabins, Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available)
8. Ethics and the Conduct of Business: John R Boatright, Pearson Education, New Delhi, 2003.
9. Fundamentals of Ethics for Scientists and Engineers: Edmund G Seebauer and Robert L Barry, Oxford University Press, Oxford, 2001.

**Course Outcomes:** At the end of this course, students will be able to

- Apply the concept of values and ethics and its application in engineering field.
- Make themselves aware about various factors influencing ethical decisions.
- Develop some practical views and skills, and instil in their mind certain basic points of ethical decision making with the help of case studies.
- Convince and resolve a moral dilemma and to take an ethical decision in case of conflicting interests.
- Develop about the social and ethical responsibilities of an engineer and his role in nation building and inclusive growth.
- Develop the basics on when and how to play a whistleblowers role if it is essential as a social responsibility to save the public and the nation.

Course code	PROJ-CSE 791				
Category	Project				
Course title	Project-II				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	12	6	
Pre-requisites (if any)	PROJ-CSE 691 and as per the technical requirements of the Project, the concerned Project Guide may prepare the pre-requisites				

- Project-II is in continuation of Project-I started in the previous semester. It holds 6 credit points.
- Students must maintain regularity in their project work.
- Students shall try to devote sufficient time and effort towards performing their project work. At the end of Semester-VII students have to submit an Intermediate Project Report comprising on progress of their proposed work. Each group should submit at least two extra copy of Intermediate Project Report other than their individual copy, one for their Project guide and one for the departmental record.

Course code	PROJ-INT 791				
Category	Project				
Course title	Internship				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	\$	2	
Pre-requisites (if any)	-----				

\$ An Internship of 40 hours per week to be done after 2<sup>nd</sup> / 4<sup>th</sup> / 6<sup>th</sup> semester examination (during semester gap)

- Students should undergo 4-6 weeks of Internship / Training on Live Projects with Industry / Govt. / NGO / PSU / Any Micro / Small / Medium Enterprise / Online Internship after their 2<sup>nd</sup> / 4<sup>th</sup> / 6<sup>th</sup> semester examination (during semester gap)
- The detailed work done during Internship along with an Internship Completion Report should be presented before a Board of Examiners

**Semester VIII (Fourth year) Curriculum**  
**Branch/Course: Computer Science and Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course	PEC-CSE VI	Professional Elective VI	3	0	0	3	100
2	Open Elective Course	OEC-X 821 <sup>#</sup>	Open Elective III	3	0	0	3	100
3	Open Elective Course	OEC-X 822 <sup>#</sup>	Open Elective IV	3	0	0	3	100
4	Project	PROJ-CSE 891	Project-III	0	0	12	6	100
<b>Total:</b>							<b>15</b>	<b>400</b>

PEC-CSE VI	
Paper Code	Paper Name
PEC-CSE 811(a)	Low Power Circuits and Systems
PEC-CSE 811(b)	Internet of Things
PEC-CSE 811(c)	Cyber Security
PEC-CSE 811(d)	Pattern Recognition

# Here X denotes the code of the offering departments such as HU/EC/EI/M/EE/ME. Refer to Appendix-I

Course code	PEC-CSE 811 (a)				
Category	Professional Elective Course (PEC)				
Course title	Low Power Circuits and Systems				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 302				

### Objectives of the course:

To expose the students to the following:

- Sources of Power dissipation in CMOS circuits
- Different approaches on supply voltage scaling
- Minimization techniques of Switched Capacitances
- Methods of controlling of Leakage Power consumption
- Concepts of Adiabatic switching and battery aware synthesis

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Basics Of MOS Transistors:</b> MOS transistor structure and device modeling, MOS inverters, MOS combinational circuits, different logic families. <b>Sources Of Power Dissipation In CMOS Circuits:</b> Static power dissipation- diode leakage power, sub threshold leakage power, gate and other tunnel currents; Dynamic power dissipation- short circuit power, switching power, glitching power. Degrees of freedom.	<b>10L</b>
<b>2.</b>	<b>Supply Voltage Scaling Approaches:</b> Technology Level- feature size scaling, threshold voltage scaling; logic level- gate sizing for voltage scaling; architecture level- parallelism and pipelining; algorithm level- transformations to exploit concurrency; dynamic voltage scaling	<b>10L</b>
<b>3.</b>	<b>Estimation and Optimization of Switching Activity:</b> Concept of Switching Activity, Reduction of Switching Activity. <b>Switched Capacitance Minimization Approaches:</b> Hardware Software Tradeoff, Bus Encoding, Two's complements verses Sign Magnitude, Clock Gating, Logic Styles.	<b>10L</b>

<b>4.</b>	<b>Leakage Power Control Techniques:</b> Threshold voltage scaling: MTCMOS, VTCMOS and DTCMOS circuits; Power gating, Transistor Stacking. <b>Special Topics:</b> Adiabatic switching, battery aware synthesis.	<b>12L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. “Low Power Digital CMOS Design” by Anantha P. Chandrakasan and Robert W. Brodersen, Kluwer Academic Publishers.
2. “Low Power CMOS VLSI circuit design” by Kaushik Roy, Sharat C. Prasad, John Willy & Sons.
3. “CMOS Digital Integrated Circuits” by S.M. Kang, Y. Leblebici, Mc Graw Hill.
4. “CMOS VLSI Design” by N.H.E Weste, D.M. Harris, A. Banerjee, Pearson Education.
5. “Principles of CMOS VLSI Design” by K. Eshraghian, N.H.E Weste, Pearson Education.
6. “VLSI Digital Signal Processing” by K. Parhi, IEEE - Wiley Press.
7. “CMOS Circuit Design Layout and Simulation” by R. J. Baker, IEEE - Wiley Press.

**Course Outcomes:** On successful completion of this course students shall be able to

- Understand the sources of power dissipation within CMOS circuits.
- Exploit supply voltage scaling approaches to mitigate power reduction within circuits.
- Estimate and optimize switching activity.
- Reduce switched capacitance values.
- Control leakage power consumption through various methods.

Course code	PEC-CSE 811(b) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Internet of Things				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	PCC-CSE 602, PEC-CSE 711(d), PEC-CSE 712(d)				

**Objectives of the course:** Throughout the course, students will be expected to demonstrate their understanding of Internet of Things by being able to do each of the following:

- Develop an understanding of the concept and various components of IoT.
- Develop skills required to build real-life IoT based projects.
- Design and implement IoT applications.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction to IoT:</b> Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.	<b>6L</b>
<b>2.</b>	<b>Elements of IoT:</b> Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication. Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	<b>8L</b>
<b>3.</b>	<b>IoT Application Development:</b> Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.	<b>18L</b>
<b>4.</b>	<b>IoT Case Studies:</b> IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.	<b>10L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. "Internet of Things (A Hands-on-Approach)", Vijay Madisetti and Arshdeep Bahga, 1st Edition, University Press.
2. "Introduction to Internet of Things: A Practical Approach", Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, ETI Labs.
3. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", Pethuru Raj and Anupama C. Raman, CRC Press.
4. "Internet of Things", Jeeva Jose, Khanna Publishing House, Delhi.
5. "Designing the Internet of Things", Adrian McEwen, Wiley.
6. "Internet of Things: Architecture and Design", Raj Kamal, McGraw Hill.
7. "Getting Started with the Internet of Things", Cuno Pfister, O' Reilly Media.
8. "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, 1st Edition, Academic Press.
9. "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Francis daCosta, 1st Edition, Apress Publications.

**Course Outcomes:** On completion of the syllabus, students will be able to:

- Understand general concepts of Internet of Things and its hardware and software components.
- Analyze basic protocols in Wireless Sensor Networks.
- Interface I/O devices, sensors & communication modules.
- Remotely monitor data and control devices.
- Develop real life IoT based projects.

Course code	PEC-CSE811(c)				
Category	Professional Elective Course (PEC)				
Course title	Cyber Security				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	BSC-M 102, BSC-M 202, ESC-CSE 201, PCC-CSE 401, PCC-CSE 404				

**Objectives of the course:**

- Define and use key terms and concepts of cyber security.
- Understand Software Design and Secure Practices.
- Identify various cyber security threats and their safeguards.
- Understand the working of intrusion detection systems.
- Understand basics of cryptography and network security.
- Understand cyber forensics and its applications.

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Cyber Security Concepts:</b> Essential Terminologies: CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering,(Social Engineering, Foot Printing & Scanning).Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners	<b>4L</b>
<b>2.</b>	<b>Cryptography and Cryptanalysis:</b> Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security, Security Protocols: - security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer-IPSec. Open Source/ Free/ Trial Tools: Implementation of Cryptographic techniques, OpenSSL, Hash Values Calculations MD5, SHA1, SHA256, SHA 512, Steganography (Stools)	<b>8L</b>

3.	<b>Infrastructure and Network Security:</b> Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation, DOS/ DDOS attacks, Asset Management and Audits, Vulnerabilities and Attacks, Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation, Open Source/ Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain & abel, iptables/Windows Firewall, snort, suricata, fail2ban	<b>5L</b>
4.	<b>Cyber Security Vulnerabilities&amp; Safe Guards:</b> Internet Security, Cloud Computing &Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness, Cyber Security Safeguards- Overview, Access control, IT Audit, Authentication, Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment, Open Source/ Free/ Trial Tools: Win Audit, Zap proxy (OWASP), burp suite, DVWA kit.	<b>6L</b>
5.	<b>Malware:</b> Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Root kits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis, Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing.	<b>5L</b>
6.	<b>Security in Evolving Technology:</b> Biometrics, Mobile Computing and Hardening on android and ios, IOT Security, Web server configuration and Security, Introduction, Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges, Open Source/ Free/ Trial Tools: adb for android, xcode for ios, Implementation of REST/ SOAP web services and Security implementations.	<b>6L</b>
7.	<b>Cyber Laws and Forensics:</b> Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards, The INDIAN Cyberspace, National Cyber Security Policy 2013, Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Scene, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations, Open Source/ Free/ Trial Tools: Case Studies related to Cyber Law, Common Forensic Tools like dd, md5sum, sha1sum, Ram dump analysis, USB device.	<b>8L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>



**Books: Text and/or Reference:**

1. William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006.
2. V.K. Jain, "Cryptography and Network Security", Khanna Publishing House.
3. Gupta Sarika, "Information and Cyber Security", Khanna Publishing House, Delhi.
4. Atul Kahate, "Cryptography and Network Security", McGraw Hill.
5. V.K. Pachghare, "Cryptography and Information Security", PHI Learning
6. Nina Godbole, "Information System Security", Wiley
7. Bothra Harsh, "Hacking", Khanna Publishing House, Delhi.

**Course Outcomes:**

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

- Understand, appreciate, employ, design and implement appropriate security technologies and policies to protect computers and digital information.
- Identify & Evaluate Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios.
- Identify common trade-offs and compromises that are made in the design and development process of Information Systems.
- Demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection

Course Code	PEC-CSE 811(d)				
Category	Professional Elective Course (PEC)				
Course Title	Pattern Recognition				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-Requisites (if any)	BSC-M202, PEC-CSE 612 (b), PEC-CSE 711 (c)				

**Objectives of the course:**

1. To equip students with basic mathematical and statistical techniques commonly used in pattern recognition.
2. To introduce students to a variety of pattern recognition algorithms.
3. Enable students to apply machine learning concepts in real life problems.

**Theory:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction :</b> Pattern Recognition: Overview, Basic Structure and Design; Pattern Recognition Paradigms: Supervised, Unsupervised, Reinforcement; Approaches: Template Matching, Geometrical Classification, Statistical, Syntactical and Neural Networks; Applications.	<b>3L</b>
<b>2.</b>	<b>Bayesian Decision Theory and Classifier:</b> Bayes Rule, Classification Problem, Bayes Minimum Error and Risk Classifier; Discriminant Functions;	<b>4L</b>
<b>3.</b>	<b>Hidden Markov Models:</b> Markov Models for Classification, HMM Parameters, Learning HMMs, Classification Using HMMs.	<b>4L</b>
<b>4.</b>	<b>Parametric Estimation:</b> Maximum Likelihood Estimation (MLE), MLE for Normal Density, Properties of MLE, Classification Example; <b>Non-Parametric Estimation:</b> Histogram, Parzen Window and Classifier, K-Nearest Neighbor Classifier and Error analysis.	<b>9L</b>
<b>5.</b>	<b>Component Analysis and Dimensional Reduction:</b> Principal Component Analysis (PCA), Face Modeling, Fisher Linear Discriminant, Multi-Dimensional Scaling (MDS), Local Linear Embedding (LLE).	<b>6L</b>
<b>6.</b>	<b>Data Clustering :</b> Hierarchical Clustering: Divisive and Agglomerative; Partitional Clustering: k-means Clustering, Expectation Maximization (EM), Fuzzy k-means Clustering; Clustering Large Data Sets: Possible Solutions, Incremental Clustering, Divide and Conquer Approach.	<b>6L</b>
<b>7.</b>	<b>Non-Metric Method:</b> Decision Trees for Pattern Classification, Construction of Decision Trees, Splitting at the Nodes, Over-fitting and Pruning: Pruning by Finding Irrelevant Attributes, Use of Cross-Validation.	<b>6L</b>
<b>8.</b>	<b>Support Vector Machine:</b> Linear Discriminant Functions, SVM for Classification, SVM Training.	<b>4L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

1. "Pattern Classification", 2/E, Wiley-Interscience, 2000, Richard O. Duda, Peter E. Hart, David G. Stork.
2. Pattern Recognition and Machine Learning (Information Science and Statistics), Christopher M. Bishop, 1/E, Springer, January 2008.
3. Pattern Recognition and Machine Learning, Springer, 2006, T. Hastie, R. Tibshirani, J. H. Friedman, Christopher M. Bishop.
4. Advances in Pattern Recognition, Springer, 2005, Shigeo Abe.

**Course Outcomes:** Students should demonstrate the ability to:

- Understand machine learning concepts and range of problems that can be handled by machine learning.
- Compare and parameterize different learning algorithms.
- Apply the machine learning concepts in real life problems.

Course code	PROJ-CSE 891				
Category	Project				
Course title	Project-III				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	0	0	12	6	
Pre-requisites (if any)	PROJ-CSE 791 and as per the technical requirements of the Project, the concerned Project Guide may prepare the pre-requisites				

- Project-III is in continuation of Project-II started in the previous semester. It also holds 6 credit points.
- Students must maintain regularity in their project work.
- The project work started during 6<sup>th</sup> semester must be completed within this semester. Each project group should prepare a Project Report by the end of this semester. Each group should submit at least three extra copy of Project Report other than their individual copy, one for their Project guide, one for the departmental library and one for Institute's main library.

## **APPENDIX-I**

### **Open Elective Courses (OEC) List**

<b>Sl. No</b>	<b>Paper code</b>	<b>Sem.</b>	<b>Name of the paper</b>
1.	OEC-HU 521(a)	5th	Sanskrit for Technical Knowledge
2.	OEC-PH 521(b)	5th	Material Science
3.	OEC-EC 521(c)	5th	Bio Medical Electronics
4.	OEC-CSE 521(d)	5th	Introduction to Object Oriented Technology & Python
5.	OEC-EI 521(e)	5th	Optical Instrumentation
6.	OEC-HU 621(a)	6th	History of Science & Engineering in India
7.	OEC-HU 621 (b)	6th	Infrastructure Finance
8.	OEC-EC 621(c)	6th	Microprocessors & Its Applications
9.	OEC-EI 621 (d)	6th	Microprocessors & Its Programming
10.	OEC-M 621(e)	6th	Computational Methods
11.	OEC-HU 721(a)	7th	Introduction to Comparative literature
12.	OEC-HU 721(b)	7th	Economic Policies in India
13.	OEC-M 721(c)	7th	Mathematical Formulation & Approximations
14.	OEC-HU 721(d)	7th	Soft Skills & Interpersonal Communication
15.	OEC-EI 721(e)	7th	MEMS
16.	OEC-EC 721(f)	7th	Nano Electronics
17.	OEC-EE 722(a)	7th	Renewable Energy
18.	OEC-ME 722(b)	7th	Modern Manufacturing Practice
19.	OEC-ME 722(c)	7th	Thermal Engineering & Fluid Machinery
20.	OEC-M 821(a)	8th	Advanced Operations Research
21.	OEC-EE 821(b)	8th	Advanced Topics in Power Systems
22.	OEC-HU 821(c)	8th	Quality Control & Management
23.	OEC-HU 821(d)	8th	Cyber Law and Computer Ethics
24.	OEC-EC 821(e)	8th	Satellite Communication
25.	OEC-EE 821(f)	8th	Energy Audit & Management
26.	OEC-HU 822(a)	8th	Digital Marketing
27.	OEC-HU 822(b)	8th	Human Resource Development & Organizational Behaviour
28.	OEC-EC 822(c)	8th	Machine Learning
29.	OEC-EI 822(d)	8th	Sensor Technology
30.	OEC-EE 822(e)	8th	Automotive Control & Robotics
31.	OEC-ME 822(f)	8th	Power Plant Engineering

**Note: Please Refer the OEC Booklet for Detailed Syllabus of these OEC papers**

## **APPENDIX-II**

### **Massive Open Online Courses (MOOCs) List**

The curriculum for Bachelor of Engineering (BE) in Computer Science & Engineering (CSE) comprise of 160 credits in a total of four year duration. A student will be eligible to get a degree with Honours, if he/she completes an additional 20 credits through MOOCs (on topics not covered in the regular curriculum) during entire 4 years of time and within the final semester (regular) examinations.

<b>Module</b>	<b>Course</b>	<b>Provider</b>	<b>Duration</b>	<b>Credit</b>	<b>Prerequisite (if any)</b>	<b>Name of the University / Institute</b>
Environmental Studies	The Science of Everyday Thinking	edX	12 weeks	4	---	University of Queensland
Soft Skills	Introduction to Philosophy: God, Knowledge, And Consciousness	edX	12 weeks	4	---	MIT
Soft Skills	Better Spoken English	NPTEL	12 week	4	---	IIT Madras
Soft Skills	English language for Competitive Exams	NPTEL	12 week	4	---	IIT Madras
Programming & Basic Computing	Introduction to Computer Science Programming Using Python	edX	9 Weeks	3	High school algebra and a reasonable aptitude for mathematics.	Massachusetts Institute of Technology
Programming & Basic Computing	Introduction to Linux	edX	14 Weeks	4	Operating Systems, Programming	Linux Foundation
Programming & Basic Computing	Android App Development for Beginners	edX	6 weeks	2	C, Java and C++ using direct 3D	GalileoX
Engineering for Society	Design, Technology and Innovation	NPTEL	8 weeks	2	---	IITB
Computing Hardware	GPU Architectures and Programming	NPTEL	12 weeks	4	Computer Organization & Architecture	IITKGP
Soft Skills	Technical English for Engineers	NPTEL	8 Weeks	3	---	IIT Madras
Soft Skills	Ethics in Engineering Practice	NPTEL	8 Weeks	3	---	IIT Kharagpur

Module	Course	Provider	Duration	Credit	Prerequisite (if any)	Name of the University / Institute
Computer Science & Applications	Web Design for Everybody (Basics Of Web Development And Coding)Speciali zation	Coursera	15weeks	4	Basics Of Web Development And Coding	University of Michigan
Soft Skills	Ethical Leadership Through Giving Voice	Coursera	4 weeks	2	---	University of Virginia
Programming & Basic Computing	An Introduction to Probability in Computing	NPTEL	4 weeks	3	Mathematics, Statistics and Programming	IIT Madras
Computer Science & Applications	Randomized Algorithms	NPTEL	12 Weeks	4	Discrete Probability Theory, Data Structure & Algorithm	IIT Guwahati
Engineering for Society	Social Network	NPTEL	12 Weeks	2	---	IIT Ropar
Computer Science & Applications	Software Security	Coursera	6 Weeks	4	Programming C, Java, C++	University of Maryland
Computing Hardware	Hardware Security	Coursera	7 Weeks	4	Digital System Design, Algorithms, Mathematics, Network Security	University of Maryland
Programming & Basic Computing	Statistics and R	edX	Self-Paced	4	Mathematics, Programming	Harvard University
Computer Science & Applications	Big Data Analysis with Apache Spark	edX	4 Weeks	4	Programming background and experience with Python required.	Berkeley, University of California
Computer Science & Applications	Machine Learning	Coursera	11 Weeks	4	Statistics, Linear Algebra, Calculus, Probability, Programming	Stanford University
Computer Science & Applications	Neural Networks and Deep Learning	Coursera	6 weeks	4	Statistics, Linear Algebra, Calculus, Probability, Programming	deeplearning .ai

Module	Course	Provider	Duration	Credit	Prerequisite (if any)	Name of the University / Institute
Computer Science & Applications	Building Applications with SAP Cloud Application Programming Model	open SAP	5 Weeks	3	Basic programming knowledge, ideally in JavaScript/Node.js and SQL	SAP
Computer Science & Applications	Discrete Optimization	Coursera	8 Weeks	3	Linear Algebra, Discrete Mathematics, Operations Research and Algorithm	University of Melbourne
Computer Science & Applications	Convolution Neural Network	Coursera	4 Weeks	4	Statistics, Linear Algebra, Calculus, Probability, Programming Languages	deeplearning.ai and Stanford University
Engineering for Society	Inter-professional Healthcare Informatics	Coursera	10 Weeks	2	---	University of Minnesota
Computer Science & Applications	Cloud Computing and Distributed Systems	NPTEL	8 weeks	4	Data Structures And Algorithms, Operating System and Networking	IITP
Computer Science & Applications	Data Science for Beginners	NPTEL	8 weeks	3	Statistics, Probability, Algorithms	IITM
Computer Science & Applications	Practical Machine Learning with Tensor flow	NPTEL	12 weeks	4	Statistics, Linear Algebra, Calculus, Probability and Python	IITM & Google
Computing Hardware	Arithmetic Circuit Complexity	NPTEL	12 Weeks	4	Computer Organization & Architecture	IIT Kanpur
Computer Science & Applications	Natural Language processing	NPTEL	12 Weeks	4	Language Translator	IIT KGP
Computer Science & Applications	Bioinformatics: Algorithm and Applications	NPTEL	12 Weeks	3	Basic knowledge on biology, algorithm, computer language	IIT Madras
Intellectual Property & Technical Writing	Road Map for Patent Creation	NPTEL	8 weeks	2	---	IIT Kharagpur

Module	Course	Provider	Duration	Credit	Prerequisite (if any)	Name of the University / Institute
Computer Science & Applications	Block chain Architecture Design and Use Cases	NPTEL	12 Weeks	4	---	IIT KGP
Computer Science & Applications	Medical Image Analysis	NPTEL	4 weeks	3	Digital Image Processing	IIT Kharagpur
Computer Science & Applications	Quantum Information and Computing	NPTEL	8 weeks	4	Basic quantum mechanics, Linear algebra and Algorithm	IIT Bombay
Programming & Basic Computing	Introduction to parallel Programming in Open MP	NPTEL	4 Weeks	4	Programming Concepts	IIT Delhi
Computer Science & Applications	Wireless Ad Hoc and Sensor Networks	NPTEL	8 weeks	3	Computer Network	IIT Kharagpur
Computing Hardware	Robotics	NPTEL	8 weeks	4	Engineering Mechanics, Basic Electronics, Digital Logic	IIT Kharagpur
Computing Hardware	Hardware modeling using Verilog	NPTEL	8 weeks	4	Digital Logic	IIT Kharagpur
Soft Skills	Leadership and Emotional Intelligence	Coursera	4 weeks	3	---	Indian School of Business
Intellectual Property & Technical Writing	Academic and Research Report	SWAYAM	8 weeks	3	---	NITTTR, Kolkata

Note:

1. Students can pursue these courses from standard course providers such as NPTEL/ Edureka / Coursera etc. on the given topics from any IITs / IISC or other standard institutes of repute.
2. The given list is not exhaustive. Students can also pursue courses on relevant topics **after proper consultation with the department.**