A. Structure of Undergraduate Engineering Program(as per AICTE Model)

Sl. No.	Category	Suggested Breakup Credit(Total of 167)
1	Humanities and Social Sciences including Management courses	16
2	Basic Science Courses	21
3	Engineering Science Courses including workshop, drawing, basic of electrical/ mechanical/computer etc.	30
4	Professional Core Courses	47
5	Professional Elective courses relevant to chosen specialization/ branch	18
6	Open Subjects – Electives from other technical and/or emerging subjects	18
7	Project work, seminar, and internship in industry or elsewhere	17
8	Mandatory Courses (Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge) like UHV I and II	-
	TOTAL	**167**

B. Our Proposed Credit System for B.Tech. Degree

Semester	HSMC	BSC	ESC	PCC	PEC	OEC	PSI	TOTAL
I	3	7	7	-	-	-	-	**17**
II	-	7	11	-	-	-	-	**18**
III	3	3	8	8	-	-	1	**23**
IV	6	-	4	12	3	-	-	**25**
V	-	-	-	11	3	6	2	**22**
VI	2	4	-	8	6	3	2	**25**
VII	2	-	-	8	6	3	4	**23**
VIII	-	-	-	-	-	6	8	**14**
TOTAL	**16**	**21**	**30**	**47**	**18**	**18**	**17**	**167**

C. Abbreviations

HSMC : Humanities, Social Science and Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Professional Core Courses

PEC : Professional Elective Courses

OEC : Open Elective Courses

PSI : Project, Seminar, and Internship

Fifth Semester ELC					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	PCC6	22ELC5PC01T	Digital Signal Processing	3-0-0	3
2	PCC7	22ELC5PC02T	Operating System	3-0-0	3
3	PCC8	22ELC5PC03T	Python Programming	3-0-0	3
4	PEC2	**Professional Elective-2:**			
		22ELC5PE01T	Artificial Intelligence	3-0-0	3
		22ELC5PE02T	Knowledge Discovery and Data Mining		
		22ELC5PE03T	Mobile Communication		
		22ELC5PE04T	Microcontroller and Applications		
		Open Elective-1 (For ELC Branch Students):			
		22EE5OE01T	Renewable Energy Systems		
		22EE5OE02T	Introduction to Electrical Properties of Materials		
		22ME5OE01T	Engineering Management		
		22ME5OE02T	Micro Electro-Mechanical System (MEMS)		
		22CE5OE01T	Building Services and Maintenance		
		22CE5OE02T	Green Technology		
		Open Elective-1 (To Other Branch Students):			
		22ELC5OE01T	Introduction to Information Theory		
		22ELC5OE02T	Fundamental of Digital System Design		
6	OEC2	**Open Elective-2(For ELC Branch Students):**			
		22EE5OE03T	Smart Grid		
		22EE5OE04T	Sensor and Instrumentation		
		22ME5OE03T	Engineering Materials		
		22ME5OE04T	Nanoscience and Technology		
		22CE5OE03T	Geo-Environmental Engineering		
		22CE5OE04T	Fluid Mechanics		
		Open Elective-2 (To Other Branch Students):			
		22ELC5OE03T	Embedded System Design		
		22EC5OE04T	Radar System Engineering		
7	MC		**Mandatory Course:**	3-0-0	0
		22CM5MC01T	Constitution of India		
		22CM5MC02T	Essence of Indian Tradition Knowledge		

Total Credit (Theory)					**18**
Practical					
1	PCC6	22ELC5PC01L	**PCC Lab-5:** Digital Signal Processing Laboratory	0-0-2	1
2	PCC7	22ELC5PC02L	**PCC Lab-6:**Operating System Laboratory	0-0-2	1
3	PCC8	22ELC5PC03L	**PCC Lab-7:**Python Programming Laboratory.	0-0-2	1
4	PSI	22CM5PS01L	Summer Internship / Summer Training / MOOC Certification	0-0-2	1
Total Credit (Practical)					**4**
Total Semester Credit					**22**

***OEC: Open Elective Courses floated for other branch students**

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Digital Signal Processing	
Course Type	Theory	
Course Code	22ELC5PC01T	
Category	**Professional Core**	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Basics of Signal and System.	
Subject Description	This course in Digital Signal Processing (DSP) provides a comprehensive exploration of fundamental concepts and techniques essential for manipulating and analyzing signals in various applications. Students will delve into the theoretical foundations of signal processing, covering topics such as convolution, Z transform, DFT and filter design. Through hands-on lab experiments students will gain practical experience in implementing DSP algorithms using software tools and hardware platforms. By the end of the course, participants will have acquired the skills necessary to design and implement advanced signal processing solutions, making them well-equipped for roles in industries ranging from telecommunications to multimedia processing.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. Analyze frequency domain characteristics of discrete-time signals. 2. Develop and apply mathematical models for digital filters. 3. Describe and implement the structural aspects of digital filters. 4. Understand and evaluate adaptive filter theory.	

<table>
<tr><td></td><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:
1. Evaluate frequency domain characteristics using the Z-Transform and Discrete Fourier Transform (DFT).
2. Implement the Fast Fourier Transform (FFT) algorithm to develop efficient systems.
3. Design and analyze digital filters.
4. Apply adaptive filter theory to real-world signal processing applications.</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. J.G.Proakis and D.G.Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, 4th Edition, PHI Learning Pvt. Ltd, 2007.
2. Tarun Kumar Rawat, Digital Signal Processing, 1st Edition,Oxford university press ,2015</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. S.Salivahanan, A.Vallavaraj, C. Gnanapriya, Digital Signal Processing, 2nd Edition, The McGraw-Hill, 2008.
2. Sanjit K. Mitra, Digital Signal Processing: A Computer - Based Approach, 4th Edition, TMH, 2013.</td></tr>
<tr><td>Digital Learning Resources</td><td colspan="2"><table><tr><td>Course Name</td><td>DIGITAL SIGFNAL PROCESSING</td></tr><tr><td>Course Link</td><td>https://nptel.ac.in/courses/117/102/117102060/</td></tr><tr><td>Course Instructor</td><td>Prof. S.C. Dutta Roy, IIT Delhi</td></tr></table><table><tr><td>Course Name</td><td>DIGITAL SIGFNAL PROCESSING</td></tr><tr><td>Course Link</td><td>https://nptel.ac.in/courses/117/105/117105144/</td></tr><tr><td>Course</td><td>Prof. Govind Sharma, IIT Kanpur</td></tr></table></td></tr>
</table>

	Instructor		

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Evaluate frequency domain characteristics using the Z-Transform and Discrete Fourier Transform (DFT).	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO2	Implement the Fast Fourier Transform (FFT) algorithm to develop efficient systems.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO3	Design and analyze digital filters.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO4	Apply adaptive filter theory to real-world signal processing applications.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

DETAILED SYLLABUS:

Module No. 1	**Z-Transform & its Applications**	**10 Hours**
Overview of Discrete time signals and systems. Z-Transform and Its Application to the Analysis of LTI Systems: Direct Z-Transform, Properties of the Z- Transform, Inverse Z-Transform by Power Series Expansion, and Partial-Fraction Expansion, Analysis of Linear Time Invariant Systems in the Z-Domain.		

Module No. 2	**Discrete Fourier Transform**	**10 Hours**
Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, DFT as a Linear		

Transformation, Relationship of DFT to other Transforms, Properties of DFT. Use of DFT in Linear Filtering: Sectional Convolution.

Module No. 3	**Efficient Computation of DFT and Structural Implementation of FIR and IIR Filter.**	**8 Hours**
Efficient Computation of DFT: FFT Algorithms, Radix-2 FFT Algorithms, Decimation-In-Time (DIT), Decimation-In-Time (DIF). Structure of IIR Systems: Direct form – I realization Direct form – II realization, Cascade and Parallel Realization. Structure of FIR Systems: Direct- Form Structure, Cascade-Form Structure, and Frequency Sampling Structure.		

Module No. 4	**Design of FIR Filter**	**4 Hours**
Design of FIR Filters: Symmetric and Antisymmetric FIR Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by Frequency-Sampling Method.		

Module No. 5	**Design of IIR Filter and fundamentals of adaptive filter**	**4 Hours**
Design of IIR filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation. Fundamentals of an adaptive filter: Adaptive filter, structure of adaptive FIR filter, application of adaptive filter.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Operating System	
Course Type	Theory	
Course Code	22ELC5PC02T	
Category	**Professional Core**	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge		
Subject Description		
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. Recognize the concepts and principles of operating systems. 2. Provide comprehensive introduction to understand the underlying principles, techniques, and approaches which constitute a coherent body of knowledge in operating systems. 3. Teach understanding how the various elements that underlie operating systems interact and provide services for execution of application software.	
	Outcomes: Upon completion of this course, the student will be able to: 1. Identify basic components of operating system. 2. Conceptualize synchronization amongst various components of a typical operating system. 3. Understand and simulate activities of various operating system components. 4. Correlate basic concepts of operating system with an existing operating system.	

<table>
<tr><td></td><td colspan="2"></td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. Abraham Silberschatz, Peter Baer Galvin & Greg Gagne - "Operating System Concepts", 8th edition, John Wiley & Sons</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. William Stallings - "Operating Systems - Internals and Design Principles", 5th edition, Pearson.

2. Charles Crowley - "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Co., 1998 edition.

3. Andrew S. Tanenbaum - "Modern Operating Systems", 2nd edition, 1995, PHI (Prentice Hall of India).</td></tr>
<tr><td>Digital Learning Resources</td><td colspan="2"><table><tr><td>CourseName</td><td>OperatingSystemFundamentals</td></tr><tr><td>CourseLink</td><td>https://nptel.ac.in/courses/106/105/106105214/</td></tr><tr><td>CourseInstructor</td><td>Prof.SantanuChattopadhyayIITKharagpur</td></tr></table></td></tr>
</table>

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Identify basic components of operating system.	

CO2	Conceptualize synchronization amongst various components of a typical operating system.	
CO3	Understand and simulate activities of various operating system components.	
CO4	Correlate basic concepts of operating system with an existing operating system.	

DETAILED SYLLABUS:

Module No. 1		**08 Hours**
Overview of operating systems: computer system organization, computer system architecture, operating system operations. Need of Process/Memory/Storage Management, Protection and security, Distributed systems, Real-Time Embedded Systems. Operating systems services, User-Operating System Interface, System calls and its types, operating system structure.		

Module No. 2		**08 Hours**
Process Concept: Process Scheduling; Operations on Processes; Inter process Communication; Thread; Multithreading models. Scheduling Criteria, Algorithms (FCFS, SJF, SRTF, Round Robin, Priority, Multi-level Queue and Feedback Queue), Thread scheduling.		

Module No. 3		**08 Hours**
The Critical-section problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical problems of synchronization, monitors. System model; Deadlock Characterization; Methods for Handling Deadlock (Deadlock prevention, detection, and Avoidance, recovery);		

Module No. 4		**06 Hours**

Swapping; Contiguous memory allocation; Paging; Structure of the page table; Segmentation; Virtual memory, demand paging, Copy-on-write, page-Replacement algorithms (FIFO, LRU, LFU, Optimal Page Replacement).

Module No. 5		**10 Hours**
File Concept: Access Methods, Directory Structure, File System Mounting, File Sharing and Protection. File system structure, File System Implementation, Directory Implementation, Allocation Methods. Overview of Mass-storage structure, disk structure, disk attachment, disk scheduling, swap-space management.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Python Programming	
Course Type	Theory	
Course Code	22ELC5PC03T	
Category	**Professional Core**	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge		
Subject Description		
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. Identify/characterize/define a problem. 2. Design a program to solve the problem. 3. Create executable code. 4. Read most Python code and write basic unit tests.	
	Outcomes: Upon completion of this course, the student will be able to: 1. To understand why Python is a useful scripting language for developers. 2. To learn how to design and program Python applications. 3. To learn how to use lists, tuples, and dictionaries in Python programs. 4. To learn how to identify Python object types.	
Assessment/ Evaluation	Mid-Term Examination	30 %
	Quiz Test-1	2.5 %
	Quiz-Test-2	2.5 %
	Surprise Test	5 %
	Assignment-1	2.5 %

	Assignment-2	2.5 %
	Attendance	5 %
	End-Term Examination	50 %
Prescribed Text Book(s)	1. Python Programming, ReemaThareja, Oxford Publications Learning Python, Mark Lutz, O'Reilly	
Reference Book(s)	1. Statistics and Machine Learning in Python Release 0.1, EdouardDuchesnay, Tommy Löfstedt 2. Python Data Analytics, Fabio Nelli, Apress	
Digital Learning Resources	Course name: Programming Data Structures and Algorithms in Python Course Link: https://nptel.ac.in/courses/106/106/106106145/ Course Instructor: Prof.MadhavanMukund, Chennai Mathematical Institute	

DETAILED SYLLABUS:

Module No. 1		**10 Hours**
Features and History of python, Literal constants, variables and identifiers, data types,Inputoperations,comments,reservewords,indentation,operatorsandexpression operations on strings go, other data types, conditional branching statements, loop structures, break, continue, pass, else. Functions definition, function call, variable scope and lifetime, return statement, more on defining functions, lambda functions, recursive functions, modules, packages in python, globals (), locals()and reload().		

Module No. 2		**06 Hours**

Concatenating, appending and multiplying strings, string formatting operator, built in string methods and functions, slice operation, ord() and chr(), in and not in operations, comparing strings, iterating strings, string module, match(),search() and sub(), findall ()and finditer ().

Module No. 3		**06 Hours**
File handling: file path, types of files, opening and closing files, reading and writing files, file position, renaming and deleting files, directory methods. Data structures: sequence, lists, functional programming, tuple, sets, dictionaries.		

Module No. 4		**10 Hours**
Classes and objects: class methods and self-arguments, the _init_(), class variable and object variable, _del_(),public and private data members, calling a class method from another class method, built-in functions to set, get and delete class attributes ,Inheritance, types, composition or containership, abstract classes or interfaces Operator overloading: implementing Operator overloading, reverse adding, overriding _getitem_()and_setitem_()methods,overridingtheinoperator,overloadingthemiscfunctions		

Module No. 5		**08 Hours**
Error and exception handling: handling exceptions, multiple exception blocks, multiple exceptions in a single block, except block without exception, else clause, raising an exception, instantiating exceptions, handling exceptions in invoked functions, built-in and user-defined exceptions, the finally block, predefined cleanup action Demonstration of NumPy, Tensor Flow, and JAX. Demonstration of ML libraries like PyTorch, Keras, and Trax, and Demonstration of graph plotting using Matplotlib.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Artificial Intelligence	
Course Type	Theory	
Course Code	22ELC5PE01T	
Category	**Professional Elective**	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge		
Subject Description		
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. To learn the concepts of Artificial Intelligence. 2. To learn the methods of solving problems using Artificial Intelligence. 3. To introduce the concepts of Expert Systems and their design procedures.	
	Outcomes: Upon completion of this course, the student will be able to: 1. Ability to comprehend AI & ES to analyze and map real-world activities to digital world. 2. Ability to identify problems that are amenably solved by AI methods. 3. Ability to design and carry out an empirical evaluation of different AI algorithms	
Assessment/ Evaluation	Mid-Term Examination	30 %
	Quiz Test-1	2.5 %
	Quiz-Test-2	2.5 %
	Surprise Test	5 %
	Assignment-1	2.5 %

	Assignment-2	2.5 %
	Attendance	5 %
	End-Term Examination	50 %
Prescribed Text Book(s)	1. Knight & Rich - "Artificial Intelligence", McGraw Hill, 3rd Edition. 2. N.J. Nilson - "Principles of Artificial Intelligence", 2nd Edition, Narosa Publishing.	
Reference Book(s)	1. Russel&Norvig - "Artificial Intelligence: A Modern Approach", 2nd Edition, Pearson. 2. D.W. Patterson - "Introduction to Artificial Intelligence and Expert Systems", Prentice Hall. 3. Joseph Giarratano, Gary Riley - "Expert Systems: Principles and Programming".	
Digital Learning Resources	CourseName	Artificial Intelligence and Expert Systems
	CourseLink	https://nptel.ac.in/courses/106106126/
	CourseName	ArtificialIntelligence
	CourseLink	https://nptel.ac.in/courses/106/105/106105079/
	CourseInstructor	Prof.P.Dasgupta,IITKharagpur

DETAILED SYLLABUS:

Module No. 1		**06 Hours**
Intelligence and AI, Agents, Model of different types of agent: reactive, deliberative, goal-driven, utility-driven, and learning agents, Environment, Properties of Environment, State Space, Knowledge, Rationality, Turing Test.		

Module No. 2		**08 Hours**
Search Techniques - definition and importance, uninformed search - DFS, BFS, iterative deepening, iterative broadening, depth-limited search, Issues in design of heuristics, Best First search, A* and AO* search, Hill climbing, Simulated Annealing, Constraint Satisfaction Problem, 8-puzzle problem, Crypto arithmetic problem.		

Module No. 3		**10 Hours**
Adversarial Search, Game Playing, min-max search, alpha-beta pruning. Knowledge Representation in AI, Logic - propositional, predicate, First Order Logic. Normal forms. Modus Ponens & Modus Tollens, Theorem Proving, Principle of Resolutions, Non-Monotonic Reasoning. Semantic Net, Frame.		

Module No. 4		**10 Hours**
Planning and its importance. Classical & partial order planning, Conditional Planning. Uncertainty, types of uncertainty, Probabilistic Reasoning - joint distribution reasoning, Bayesian networks, learning, explanation-based learning, induction learning - Decision Tree, statistical learning - Bayesian learning, expectation maximization, hidden Markov model, closed world problems.		

Module No. 5		**06 Hours**
Expert Systems – Design Techniques, components, Problem and knowledge domain, Knowledge engineering approach, error in design of expert system, lifecycle of expert system, MYCIN and DENDRAL – an expert system.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Knowledge Discovery and Data Mining	
Course Type	Theory	
Course Code	22ELC5PE02T	
Category	**Professional Elective**	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge		
Subject Description		
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. Identify the scope and necessity of Data Mining and Knowledge Discovery. 2. To understand various tools of Data Mining and their techniques to solve real-time problems. 3. To develop ability to design various algorithms based on data mining tools. 4. To develop further interest in research and design of new Data Mining techniques.	
	Outcomes: Upon completion of this course, the student will be able to: 1. Identify and distinguish data mining applications from other IT applications 2. Describe data mining algorithms 3. Describe applicability of data mining 4. Suggest appropriate solutions to data mining problems	

Assessment/ Evaluation	Mid-Term Examination	30 %
	Quiz Test-1	2.5 %
	Quiz-Test-2	2.5 %
	Surprise Test	5 %
	Assignment-1	2.5 %
	Assignment-2	2.5 %
	Attendance	5 %
	End-Term Examination	50 %
Prescribed Text Book(s)	1. Jiawei Han, MichelineKamber, and Jian Pei - "Data Mining: Concepts and Techniques", Third Edition, Elsevier. 2. Data Warehousing, Data Mining & OLAP by Alex & Stephen, McGraw Hill.	
Reference Book(s)	1. VikramPudi& P. Radha Krishna, Data Mining, Oxford University Press. 2. ReemaThareja, Data Warehousing, Oxford University Press.	
Digital Learning Resources	CourseName: DataMining CourseLink: https://nptel.ac.in/courses/106/105/106105174/ CourseInstructor: Prof.PabitraMitra, IITKharagpur	

DETAILED SYLLABUS:

Module No. 1		**06 Hours**
Knowledge Discovery in Databases (KDD) process: data integration, mining, and interpretation of patterns in large collections of data. Overall Architecture, Data Warehouse Database Sourcing.		

Module No. 2		**06 Hours**
Data pre-processing techniques: Acquisition, Clean-up & Transformation Tools, Metadata data mining techniques for classification, regression, clustering, deviation detection, and association		

analysis; and evaluation of patterns mined from data.

Module No. 3		**10 Hours**
Data Warehousing Component, Defining Features, data warehouses and data marts, overview of the components, metadata in the data warehouse. OLAP in the Data Warehouse: Demand for Online analytical processing, need for multidimensional analysis, OLAP definitions and rules, OLAP characteristics, major features, dimensional analysis, hypercube. Drill-down and roll-up, slice-and diceorrotation, OLAP models, overview of MOLAP model, ROLAP model, ROLAP versus MOLAP.		

Module No. 4		**12 Hours**
Data Mining Basics: What is Data Mining, Data Mining Defined, The knowledge discovery process, OLAP versus data mining, data mining and the data warehouse, Major Data Mining Techniques, Cluster detection, decision trees, memory-based reasoning, link analysis, neural networks, Data Mining Applications, Benefits of Data Mining in industry, banking and finance.		

Module No. 5		**06 Hours**
Web mining: classifying web pages, extracting knowledge from the web, mining the World Wide Web, Spatial Data Mining, Multimedia Data Mining, Text Mining		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ECE (Electronics and Communication Engineering)	
Semester	5th	
Subject Name	MOBILE COMMUNICATION	
Course Type	Theory	
Course Code	22ELC5PE03T	
Category	PEC	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Digital Communication.	
Subject Description	This Course is to expose the students to the most recent technological developments in Mobile communication systems. The Course considers the basic concepts of cellular system. Following this, various propagation effects and propagation models used in mobile communication are included in the course. This course deals with various methodologies to improve the received signal quality in mobile communication. The Course provides various multiple access techniques and Standards in Cellular mobile Communication. The objective of this course is to enable the student to understand the emerging technologies of wireless and mobile communications	
Objectives and	**Objectives:** The course should enable the students: 1. Basic cellular concepts and capacity enhancement techniques like	

<table>
<tr><td rowspan="2">Outcomes</td><td colspan="2">sectoring, cell splitting, microcell, picocell etc.
2. Analysis of various channel models and fading characteristics.
3. Various multiple access techniques and spread spectrum techniques.
4. Principles and applications of various cellular mobile communication systems.</td></tr>
<tr><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:

1. Identify and discuss the fundamental operational and design problems of cellular mobile communication systems.
2. Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling
3. Explore various wireless mobile communication standards and analyze their system performance.
4. Analyze various multiple access techniques and compare their system performance in terms of capacity and spectral efficiency.</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
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<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. Wireless Communication and Networking, Essential Reading: V K Garg, Morgan Kaufman Publishers, 2008, India
2. Wireless Communications: T S Rappaport, 2nd Edition, Pearson Education, 2018, India.</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. Wireless Communications: T L Singhal, 1st Edition, Tata McGraw Hill, 2010, India.
2. Wireless communication: A Goldsmith, 1st Edition, Cambridge University Press, 2009, India</td></tr>
</table>

Digital Learning Resources	Course Name	Introduction to Wireless and Cellular Communication
	Course Link	https://nptel.ac.in/courses/106/106/106106167/
	Course Instructor	Prof. David Koilpillai, Department of Electrical Engineering , IIT Madras
	Course Name	Wireless communication
	Course Link	https://nptel.ac.in/courses/117102062
	Course Instructor	Prof. Ranjan Bose, IIT Delhi

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Identify and discuss the fundamental operational and design problems of cellular mobile communication systems.	PO1, PO2, PO3, PO4, PO5
CO2	Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling	PO1, PO2, PO3, PO5
CO3	Explore various wireless mobile communication standards and analyze their system performance.	PO1, PO2, PO3, PO4, PO5, PO6
CO4	Analyze various multiple access techniques and compare their system performance in terms of capacity and spectral efficiency.	PO1, PO2, PO3, PO4, PO5, PO6

DETAILED SYLLABUS:

Module No. 1	**Fundamentals of Cellular Communications**	**10 Hours**
Introduction, Cellular Systems: Hexagonal Cell Geometry, Frequency reuse, channel Assignment; Handoff Strategies; Interfaces and System Capacity-Co-channel Interference Ratio, Cellular System Design in Worst-Case Scenario with an Omni directional Antenna, Co-channel Interference Reduction, ACI, Cell Splitting; Sectoring, Directional Antennas in Seven-Cell		

Module No. 2	Radio Propagation Models	08 Hours
Large Scale Propagation: Introduction, Free Space Propagation Model; Basic propagation mechanisms, Free-space Attenuation, Attenuation over Reflecting Surfaces; Outdoor propagation Path Loss Models; Indoor Propagation Path Loss Model Small Scale Propagation: small scale multi path propagation; Characteristics of Wireless Channel, Parameters of multi path channels; types of multi path fading; Signal Fading Statistics.		

Module No. 3	Multiple Access Techniques	06Hours
Introduction, Narrowband Channelized Systems, Comparisons of FDMA, TDMA and DS-CDMA, Comparison of DS-CDMA vs. TDMA; Spectral Efficiency, System Capacity, Capacity of a DS-CDMA System		

Module No. 4	Equalization, Diversity	06 Hours
- Fundamentals of equalization, General adaptive equalizer, types of equalizers, diversity techniques (space, polarization, time, frequency, RAKE receivers.,		

Module No. 5	Fourth Generation Systems and New Wireless Technologies	06 Hours
Next Generation Cellular Technology 4G: Evolution of technology to 4G wireless, 4G evolution, 4G technologies, 4G technologies, Orthogonal frequency-division multiplexing, 4G technologies **Wireless Local Area Networks**: WLAN topologies, wireless local area network standard IEEE 802.11, IEEE 802.11 architecture, WiMAX and IEEE 802.16, WiMAX architecture and Mechanism.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	**Microcontroller & applications**	
Course Type	Theory	
Course Code	22ELC5PE04T	
Category	Professional Elective	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge		
Subject Description	Microcontrollers are commonly used in various applications, such as robotics, automotive, consumer electronics, and medical devices. They are preferred over other processors due to their low cost, low power consumption, and small size. All this makes them an ideal choice for embedded systems. The **MSP430** is a mixed-signal microcontroller family from Texas Instruments. It is built around a 16-bit CPU, the MSP430 is designed for low cost and, specifically, low power consumption embedded applications. This course is designed to help users to get in-depth knowledge about the MSP430 microcontroller.	
Objectives	**Objectives:** The course should enable the students to:	

<table>
<tr><td>and

Outcomes</td><td colspan="2">1. Understand the basics of Microprocessor and Microcontroller.
2. Describe the main components and working principle of the Intel 8086 microprocessor.
3. Explain industry standard microcontroller and its application.
4. Learn assembly language program in 8086 and MSP430.</td></tr>
<tr><td></td><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:

1. Outline comprehensive knowledge on basics of microprocessor and microcontroller.
2. Explain the internal architecture, organization and Addressing modes of 8086 Microprocessors.
3. Describe the architectural features and instruction set of MSP430.
4. Investigate the design aspect and development of interfacing I/O devices with MSP430 microcontroller.</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. A.K.Ray and K.M.Bhurchandi, “Advanced Microprocessors and Peripherals”,Tata McGrawHill, 3rd edition July 2017.
2. The 8051 and MSP430 Microcontrollers: Architecture, Programming and Applications, K. Uma Rao, Andhe Pallavi, Wiley Publication, 2019.</td></tr>
</table>

Reference Book(s)	1. Barry B. Brey, The Intel Microprocessors, Architecture, Programming and Interfacing-, 8e, 2009, Pearson Education, ISBN 0-13-502645-8 2. Doughlas.V.Hall, " Microprocessor and Interfacing : Programming and Hardware", 2nd edition, McGraw Hill, 2012 3. John H. Davies, MSP430 microcontroller basics, 1st Edition, Newnes Publication , 2008, Oxford USA.	
Digital Learning Resources	**Course Name**	Introduction to Embedded System Design
	Course Link	https://nptel.ac.in/courses/108/102/108102169/
	Course Instructor	Prof. Dhananjay V. Gadre, Prof. Badri Subudhi, Netaji Subhas University of Technology, IIT Jammu
	Course Name	Microcontrollers and Applications
	Course Link	https://nptel.ac.in/courses/117/104/117104072/
	Course Instructor	Dr. S.P. Das, Electronics & Communication Engineering, IIT Kanpur

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Outline comprehensive knowledge on basics of microprocessor and microcontroller.	PO1, PO3, PO6, PEO1, PEO3
CO2	Explain the internal architecture, organization and Addressing modes of 8086 Microprocessors.	PO1, PO3, PO6, PO9,PEO1, PEO3
CO3	Describe the architectural features and instruction set of MSP430.	PO1, PO2, PO3, PO12, PEO1, PEO3
CO4	Investigate the design aspect and development of interfacing I/O devices with MSP430 microcontroller.	PO1, PO2, PO3, PO4, PO6, PO7, PO9, PO12, PEO1, PEO3

DETAILED SYLLABUS:

Module No. 1	**Introduction to Microprocessors and Microcontrollers**	**06 Hours**
Overview of Microcomputer organization, Common Terminologies Associated with Computing Systems, Microprocessors and Microcontrollers, CISC and RISC Systems, Computing Languages, Computer Architecture: Harvard and Von-Neumann, Evolution of Microprocessors and Microcontrollers.		

Module No. 2	**Intel 8086 Microprocessor**	**10 Hours**
Introduction, 8086 Programmer's model: Register organization, Hardware Architecture: Bus interface unit (BIU), Execution unit (EU), Pipelined operation, Memory banking, physical address generation and Memory segmentation. 8086 Pin description: Common, Minimum and maximum mode Pin and Signals, Bus cycle and System configuration (Minimum mode only). Interrupt. 8086 Addressing modes, Instruction sets Assembler directive and programming.		

Module No. 3	**MSP Microcontroller Introduction and Key Features**	**06 Hours**
Introduction, Low Power Applications, MSP430 RISC CPU Architecture and pin configuration, Details of 16-Bit RISC CPU, Clock System, Memory subsystem, Key differentiating factors between different families, Digital I/O Ports.		

Module No. 4	**Programming the MSP430**	**08 Hours**
Addressing Modes, Instruction Set of MSP430, Double Operand Core Instructions, Single Operand Core Instructions (Format II), Program Flow control, Emulated Instructions, Movement Instructions, Implementation of Decimal Arithmetic, Shift and Rotate Instructions, Programming in ALP.		

Module No. 5	**On Chip Peripherals, Interfacing and Applications of MSP430**	**06 Hours**
Watchdog Timer, Timers, Real Time Clock, Digital-to-Analog Conversion, ADC (Analog to digital converter), LCD controller, LED and external memory.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Introduction to Information Theory	
Course Type	Theory	
Course Code	22ELC5OE01T	
Category	Open Elective	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Communication engineering	
Subject Description	Information theory is the science of measuring, maintaining, transmitting, and estimating information in random data. This course provides students with analytical skills to measure information, make inferences, and investigate the relationship between information and learning. The course discusses information measurements, source and channel coding theorems, and statistical inference.	
Objectives and Outcomes	**Objectives:** The course should enable the students: 1. To provide a clear understanding on the concept of information in communication theory and how it affects communication receiver design. 2. To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and	

<table>
<tr><td></td><td colspan="2">channel coding algorithms.
3. To develop the ability to analyze the error correcting codes used for reliable transfer of data
4. To familiarize with various decoding techniques</td></tr>
<tr><td></td><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:

1. Acquire knowledge about concept of mutual information, entropy in information theory.
2. Implement the various types of source coding algorithms and analyze their performance.
3. Utilize the concept to design a communication model and evaluate its channel capacity
4. Understand and analyze various error correcting codes used for reliable transfer of data</td></tr>
<tr><td rowspan="8">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. Error Control Coding- Fundamentals and Applications: Shu Lin, Daniel J.Costello,Jr, Prentice Hall, Inc 2014.
2. Information Theory, Coding and Cryptography:Ranjan Bose, 2nd Edition, 2009, TMH.</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. Elements of Information Theory, Thomas M. Cover and Joy A. Thomas, 2nd edition, John Wiley, 2006.
2. Digital Communications- Fundamentals and Applications, Bernard Sklar, 2nd Edition, Pearson Education, 2016</td></tr>
</table>

Digital Learning Resources	Course Name	Information Theory and Coding
	Course Link	https://nptel.ac.in/courses/117101053
	Course Instructor	Prof. Prof. S.N. Merchant, IIT Bombay
	Course Name	Information Theory, Coding and Cryptography
	Course Link	https://nptel.ac.in/courses/108102117
	Course Instructor	Prof. Ranjan Bose, IIT Delhi

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Acquire knowledge about concept of mutual information, entropy in information theory.	PO1, PO2, PO3, PO4, PO5
CO2	Implement the various types of source coding algorithms and analyze their performance.	PO1, PO2, PO3, PO5
CO3	Utilize the concept to design communication models and evaluate the channel capacity	PO1, PO2, PO3, PO4, PO5, PO6
CO4	Understand and analyze various error correcting codes used for reliable transfer of data	PO1, PO2, PO3, PO4, PO5, PO6

DETAILED SYLLABUS:

Module No. 1	**Information Theory**	**8 Hours**
Introduction, Measure of information, Information content of message, Average Information, Entropy and Information rate. **Source Coding:** Encoding of the Source Output, Shannon's Encoding Algorithm, Shannon-Fano Encoding Algorithm, Source coding theorem, Prefix Codes, Kraft McMillan Inequality.		

Module No. 2	**Information Channels**	**07 Hours**

Information Channels: Communication Channels, Discrete Communication channels Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies. Mutual Information, Channel Capacity, Channel Capacity of Binary Symmetric Channel, Binary Erasure Channel

Module No. 3	**Linear Block Codes**	**06 Hours**
Error Control Coding: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error detection & Correction capabilities ofLinear Block Codes, Single error correction Hamming code, Table lookup Decoding using Standard Array.Perfect Codes, Hamming Codes		

Module No. 4	**Cyclic Codes**	**10 Hours**
Binary Cyclic Codes: Algebraic Structure of Cyclic Codes, Encoding using an (n-k) Bit Shift register, Syndrome Calculation, Error Detection and Correction **BCH Code:**Introduction, Primitive elements, minimum polynomials, Examples of BCH codes, Decoding of BCH codes		

Module No. 5	**Convolution Codes**	**07 Hours**
Introduction, Tree Codes and Trellis Codes, Polynomial description, The Generating function, Matrix Description, Viterbi Decoding, Distance bounds, Turbo Codes, Turbo Decoding.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Fundamental of Digital System Design	
Course Type	Theory	
Course Code	22ELC5OE02T	
Category	Open Elective	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	The present world is an era of digital technology, where we are surrounded by computations going all around and devices connected to each other. To meet this challenge digital systems play a crucial role for the development of societal needs. To understand the course students should have basic knowledge on digital electronics and circuits. Fundamentals of digital logic principles, including Boolean algebra, combinational and sequential logics will help the students to have a deep understanding of the subject and helps to synchronize with industry needs.	
Subject Description	The course starts with a review on some fundamental blocks of combinational and sequential logic. It touches different types of FSM blocks and state tables followed by the principles to design robust Synchronous Sequential Circuits with fundamental timing issues. It also covers the design of sequential networks with programmable devices.	

<table>
<tr><td rowspan="2">Objectives

and

Outcomes</td><td colspan="2">Objectives:

The course should enable the students to:

1. To enhance the knowledge in Digital system design.
2. To study the capabilities of Finite State Machines.
3. To understand the design techniques and timing issues of synchronous sequential circuits.
4. To explore the sequential circuit design using programmable logic devices.</td></tr>
<tr><td colspan="2">Outcomes:

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

1. Understand the various types of FSMs and their capabilities
2. Synthesize different types of synchronous sequential logic circuits using Melay and Moore model
3. Analyze the timing issues to have an error free design
4. Develop the skill to design Sequential Networks using ROMs</td></tr>
<tr><td rowspan="8">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. Charles H. Roth, Jr, Fundamentals of Logic Design, JPH, 4th Edition, 1999, Mumbai
2. Stephen Brown, ZvonkoVranesic, Fundamentals of Digital Logic with Verilog Design, Tata McGraw-Hill, 1st Edition 2002, New Delhi</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. John Wakerley, Digital Design: Principles and Practices, Pearson Education, 4th Edition, 2006</td></tr>
</table>

<table>
<tr><td></td><td>2. Moris M. Mano, Digital Design, Pearson Education, 3rd Edition, 2002, Delhi</td></tr>
<tr><td>Digital Learning Resources</td><td>
<table>
<tr><td>Course Name</td><td>Digital System Design</td></tr>
<tr><td>Course Link</td><td>https://nptel.ac.in/courses/108/106/108106177/</td></tr>
<tr><td>Course Instructor</td><td>Prof. NeerajGoel, Department of Computer Science Engineering, IIT Ropar</td></tr>
</table>
<table>
<tr><td>Course Name</td><td>Digital System Design</td></tr>
<tr><td>Course Link</td><td>https://nptel.ac.in/courses/117/105/117105080/</td></tr>
<tr><td>Course Instructor</td><td>Prof. D. Roychoudhury, Electronics & Communication Engineering, IIT Kharagpur</td></tr>
</table>
</td></tr>
</table>

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Understand the various types of FSMs and their capabilities	PO1, PO2, PO3, PO4, PO6
CO2	Synthesize different types of synchronous sequential logic circuits using Melay and Moore model	PO1, PO2, PO3, PO4,PO6, PO7
CO3	Analyze the timing issues to have an error free design	PO1, PO2, PO3, PO4, PO5, PO6
CO4	Develop the skill to design Sequential Networks using ROMs	PO1, PO2, PO3, PO4, PO5, PO6, PO7

DETAILED SYLLABUS:

Module No. 1	**Combinational and Sequential Logic**	**10 Hours**
Review of Adders, Multipliers, Multiplexers, ROM, Triggering of flip-flops, Flip flop behavior for Synchronous and Asynchronous reset signal, Design procedure for sequential circuits, Design of synchronous counter for random sequence.		

Module No. 2	**Introduction to FSM and Reduction of State Tables**	**07 Hours**
Finite state model, State graphs and tables, Capabilities and limitations of FSM, State reduction and assignment, One-Hot Encoding, Moore and Mealy state models		

Module No. 3	**Synchronous Sequential Circuits**	**06 Hours**
Analysis and Synthesis of Synchronous sequential circuits, Top down and Bottom up Approach to Design, Design of Serial Adder: using Mealy type FSM, using Moore type FSM		

Module No. 4	**Sequential Network Design with Programmable Logic Devices (PLDs)**	**10 Hours**
Static Random Access Memory (SRAM), SRAM blocks in PLDs, Design of Sequential Networks using ROMs		

Module No. 5	**Timings of Sequential Circuit**	**07 Hours**
Delay of combinational circuit. Set-up and hold time, Clock Synchronization: Clock skew, Asynchronous inputs to flip fops, Switch de bouncing.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Embedded System Design	
Course Type	Theory	
Course Code	22ELC5OE03T	
Category	Professional Elective	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Microprocessor and Microcontroller	
Subject Description	An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is designed for a specific function or for specific functions within a larger system. Industrial machines, agricultural and process industry devices, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys as well as mobile devices are all possible locations for an embedded system.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. To enhance the knowledge in Embedded System 2. To study the controller architecture. 3. To explore the knowledge of interfacing of external devices.	

<table>
<tr><td></td><td colspan="2">4. To understand the design techniques of embedded system.</td></tr>
<tr><td></td><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:

1. Able to acquire knowledge and understand fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware,
2. Able to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system
3. Able to practically apply gained theoretical knowledge in order to design, analyze and implement embedded systems, e.g. integrating embedded subsystems
4. Able to get detail knowledge of MSP430 Launch pad embedded board</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. Designing Embedded Hardware, John Catsoulis. 2nd edition. Shroff Publishers and Distributors. ISBN-10: 9788184042597</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. Embedded System Design: A Unified Hardware / Software Introduction.
2. Tony Givargis and Frank Vahid. Wiley. ISBN-10: 812650837XMSP430 Microcontroller Basics. John H. Davies. Elsevier. ISBN-10: 9789380501857. Programming Embedded Systems in C and C++. Micheal Barr. Shroff Publishers and Distributors. ISBN-10: 817366076X</td></tr>
</table>

Digital Learning Resources	Course Name	**Embedded System Design**
	Course Link	https://onlinecourses.nptel.ac.in/noc20_ee98/preview
	Course Instructor	By Prof. Dhananjay V. Gadre, Prof. BadriSubudhi | NetajiSubhas University of Technology, IIT Jammu

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	To enhance the knowledge in Embedded System	
CO2	To study the controller architecture.	
CO3	To explore the knowledge of interfacing of external devices.	
CO4	To understand the design techniques of embedded system.	

DETAILED SYLLABUS:

Module No. 1	**Introduction to Embedded Systems**	**08 Hours**
Introduction to Embedded Systems and Computer Systems Terminology. Modular approach to Embedded System Design using Six-Box model: Input devices, output devices, embedded computer, communication block, host and storage elements and power supply. Microcontroller Based Embedded System Design. Salient Features of Modern Microcontrollers. Introduction to MSP430 Microcontroller. MSP430 CPU Architecture. Programming Methods for MSP430. Introduction to Lunchbox Platform.		

Module No. 2	**Fundamentals of Physical Interfacing**	**06 Hours**
Connecting Input Devices: Switches, Keyboard and Output devices: LEDs, Seven Segment Displays (SSD), OLED.		

Module No. 3	Programming the MSP430	06Hours
Installing and using Code Composer Studio(CCS). Introduction to Embedded C. Interfacing LEDs and Switches with MSP430 using Digital Input and Output.		

Module No. 4	MSP430 Clock and Reset System	10 Hours
MSP430 Clock sources and distribution. Types of Reset sources. Handling Interrupts in MSP430. Writing efficient Interrupt Service Routine (ISR). Introduction to MSP430 Timer Module and its Modes of Operation.Timer Capture Modes. Measuring frequency and time period of external signals and events. Generating Pulse Width Modulation (PWM) using Timer Capture Mode.		

Module No. 5	Interfacing and Serial Data Communication	10 Hours
Interfacing Liquid Crystal Displays with MSP430. Low Power Modes in MSP430. ADC operation in MSP430. Interfacing analog inputs. Adding DAC to MSP430. Custom Waveform generation using MSP430. Serial Communication Protocols: UART, SPI, I2C. Interfacing Universal Serial Communication Interface (USCI) Module of the MSP430 for UART Communication.		

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	Radar Engineering	
Course Type	Theory	
Course Code	22EC5OE04T	
Category	**Professional Elective**	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Communication Engineering	
Subject Description	The "Radar Engineering" course offers an in-depth exploration of radar systems, focusing on their principles, types, and applications. Students will study continuous wave (CW), frequency modulated (FM-CW), moving target indication (MTI), and pulse Doppler radar systems, as well as their components and functionalities. The course emphasizes radar signal processing, tracking methods, and the influence of environmental factors on detection. Through lectures and tutorials, students will develop skills to analyze radar signals, understand system limitations, and apply radar technologies in real-world scenarios, preparing them for advanced studies or careers in electronics and communication engineering.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. Identify basic radar systems and their fundamental components. 2. Explain radar equations and principles of signal processing. 3. Use radar concepts to solve detection and range estimation problems. 4. Analyze radar system performance and limitations in different scenarios.	
	Outcomes: Upon completion of this course, the student will be able to: 1. Demonstrate an understanding of radar fundamentals and factors that influence the detection process. 2. Differentiate radar types based on their operational principles and fields of application. 3. Familiarize with radar displays and their applications in real-time scenarios.	

<table>
<tr><td></td><td colspan="2">4. Analyze radar signals and system components, applying tracking principles to enhance detection accuracy.</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. Merrill I. Skolnik, Introduction to Radar Systems, Third Edition, Tata McGraw-Hill, 2001, New Delhi.</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. Byron Edde, Radar Principles, Technology, Applications, First Edition, Pearson Education, 2007, New Delhi.
2. Nathanson, Radar Design Principles, Second Edition, Mc-Graw Hill, 1991, New York.
3. Peyton Z. Peebles, Radar Principles, First Edition, Wiley, 1998, New York.
4. Mark A. Richards, James A. Scheer, William A. Holm. Yesdee, Principles of Modern Radar: Basic Principles, First Edition, Scitech Publishing, 2013, Raleigh, North California</td></tr>
<tr><td>Digital Learning Resources</td><td colspan="2"><table><tr><td>Course Name</td><td>Radar System Engineering</td></tr><tr><td>Course Link</td><td>https://nptel.ac.in/courses/108/105/108105154/</td></tr><tr><td>Course Instructor</td><td>Prof. Amitabha Battacharya, Department of Electronics and Electrical Communication Engineering, IIT Kharagpur</td></tr></table></td></tr>
</table>

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Demonstrate an understanding of radar fundamentals and factors that influence the detection process	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

CO2	Differentiate radar types based on their operational principles and fields of application	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO3	Familiarize with radar displays and their applications in real-time scenarios	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO4	Analyze radar signals and system components, applying tracking principles to enhance detection accuracy	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

DETAILED SYLLABUS:

Module No. 1	**Introduction to Radar**	**10 Hours**

Introduction to Radar:

Basic radar, maximum unambiguous range, building blocks of radar, simple form of radar equation, Block diagram of Radar transmitter, Radar frequencies. Applications to radar.

Radar equation:

Prediction of Range performance, minimum detectable signal, receiver noise, SNR. Radar Cross Section, transmitter power, PRF, range ambiguities, and system losses.

Module No. 2	**CW and FM-CW Radar**	**8 Hours**

CW and Frequency Modulated Radar:

Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar.

FM-CW Radar:

Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding

Targets).

Module No. 3	MTI and Pulse Doppler Radar	6 Hours

MTI and Pulse Doppler Radar:

Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Staggered PRFs. MTI Radar Parameters, Limitations to MTI Performance. MTI versus Pulse Doppler Radar.

Module No. 4	Tracking Radar	6 Hours

Tracking Radar:

Tracking with Radar- Types of Tracking Radar Systems, Monopulse Tracking- Amplitude Comparison Monopulse. Phase Comparison Monopulse. Sequential Lobing, Conical Scan Tracking, Block Diagram of Conical Scan Tracking Radar, Tracking in Range.

Module No. 5	Radar Receiver and Modern Radars	6 Hours

Radar Receiver:

Block Diagram of Radar Receiver & Radar Displays- A-scope and PPI.

Modern Radars:

Height Finding Radars, Synthetic Aperture Radar.

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5th	
Subject Name	**Digital Signal Processing Laboratory**	
Course Type	Laboratory	
Course Code	22ELC5PC01L	
Category	**Professional Core**	
Credit Point	1	
Time Commitment	Lecture	05 Hours
	Tutorial	Nil
	Practice	20 Hours
	Total	25 Hours
Recommended Background Knowledge/Course Pre-requisites	MATLAB, CODECOMPOSER STUDIO	
Subject Description	The course will introduce the students to solve and simulate problems in the areas of communications and signal processing using MATLAB environment and programming aspects as well as programming of DSP hardware for real-time signal processing applications.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. Learn to use MATLAB for digital signal processing simulations. 2. Gain familiarity with the architecture of the DSP Processor (TMS	

	320C6748) and its applications. 3. Implement FIR and IIR filters using both hardware and software. 4. Apply adaptive filter theory to real-time signal processing applications.	
	Outcomes: Upon completion of this course, the student will be able to: 1. Learn MATLAB and DSP kit fundamentals for lab experiments and applications. 2. Sketch the magnitude and phase response of DFT, Inverse DFT and FFT of discrete time signals. 3. Design and analyze digital filters for processing of discrete time signals using MATLAB and DSP kit. 4. Simulate various signals processing algorithm in both hardware and software.	
Assessment/ Evaluation	Lab Experiments	20%
	Record Writing	10%
	Behavior/ Attitude	05%
	Quiz	10%
	Attendance	05%
	Final Lab Test	30%
	Final Viva/ Final Lab Quiz Test	20%
Prescribed Text Book(s)	J.G.Proakis and Vinay K.Ingle Digital Signal Processing A MATLAB Based Approach, 3rd Edition, CENGAGE Learning Pvt. Ltd, 2008.	
Digital Learning Resources		

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Learn MATLAB and DSP kit fundamentals for lab experiments and applications.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO2	Sketch the magnitude and phase response of DFT, Inverse DFT and FFT of discrete time signals.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO3	Design and analyze digital filters for processing of discrete time signals using MATLAB and DSP kit.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
CO4	Simulate various signals processing algorithm in both hardware and software.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

DETAILED SYLLABUS (EXPERIMENTS):

Sl. No.	Name of Experiments (AT LEAST 10 EXPERIMENTS SHOULD BE DONE)	Duration in Hrs
1	Familiarization with the architecture of a standard DSP kit (Preferably TMS 320C6XXX DSP kit of Texas Instruments)	2
2	Generation of different types of signals (SIN, COS, RAMP, TRAINGULAR, RANDOM) using DSK 6748 KIT.	2
3	Linear convolution of sequences using DSP 6748 KIT.	
4	To find DFT / IDFT of given DT signal using MATLAB and DSK 6748 KIT.	2
5	Circular convolution of two sequences and comparison of the result with the result obtained from linear convolution using MATLAB and DSP	2

	6748 kit.	
6	Program to obtain Linear Convolution of Long duration sequences using Overlap Add and Overlap Save using MATLAB.	2
7	Implementation of FFT algorithm by decimation in time and decimation in frequency using MATLAB.	2
8	Design and implementation of FIR Low Pass Filters using windowing techniques (rectangular window, triangular window and Kaiser window) in MATLAB and DSP kit.	2
9	Design and implementation of FIR High Pass Filters using windowing techniques (rectangular window, triangular window and Kaiser window) in MATLAB and DSP kit.	2
10	Implementation of Low Pass IIR filters for a given sequence using MATLAB and DSK 6748 KIT.	2
11	Implementation of High Pass IIR filters for a given sequence using MATLAB and DSK 6748 KIT.	
12	Implementation of LMS algorithm using MATLAB and DSP 6748 kit.	

BEYOND SYLLABUS (EXPERIMENTS):

Sl. No.	Name of Experiments (AT LEAST 10 EXPERIMENTS SHOULD BE DONE)	Duration in Hrs
1	Implementation of Decimation Process using MATLAB and DSK 6748 KIT.	2
2	Implementation of Interpolation Process using MATLAB and DSK 6748 KIT.	2
3	Design and implementation of Adaptive noise cancellation.	2
4	To write a C- program to compute power density spectrum of given one – dimensional signal and plot.	2
5	Image sharpening using DSP Processor.	2

COURSE DESCRIPTION:

Degree	B. Tech.	
Level	Undergraduate	
Branch	ELC (Electronics and Computer Engineering)	
Semester	5^{th}	
Subject Name	**Operating System Laboratory**	
Course Type	Laboratory	
Course Code	22ELC5PC02L	
Category	**Professional Core**	
Credit Point	1	
Time Commitment	Lecture	05 Hours
	Tutorial	Nil
	Practice	20 Hours
	Total	25 Hours
Recommended Background Knowledge/Course Pre-requisites	MATLAB, CODECOMPOSER STUDIO	
Subject Description	The course will introduce the students to solve and simulate problems in the areas of communications and signal processing using MATLAB environment and programming aspects as well as programming of DSP hardware for real-time signal processing applications.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. To introduce Basic Linux general purpose Commands. 2. To learn network Linux commands. 3. To learn shell script.	

<table>
<tr><td></td><td colspan="2">4. To learn different programming languages in Linux editor environment and implement different Operating system algorithm.

5. To learn about file management and different types of permission setup.

6. To understand how system processes work and how to manage them.</td></tr>
<tr><td></td><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:

1. Experiment with Unix commands and shell programming.

2. Able to implement algorithm for process and File system management with system calls.

3. Able to implement and analyse the performance of different algorithm of Operating Systems like CPU scheduling algorithm, page replacement algorithms, deadlock avoidance, detection algorithms and so on.</td></tr>
<tr><td rowspan="7">Assessment/ Evaluation</td><td>Lab Experiments</td><td>20%</td></tr>
<tr><td>Record Writing</td><td>10%</td></tr>
<tr><td>Behavior/ Attitude</td><td>05%</td></tr>
<tr><td>Quiz</td><td>10%</td></tr>
<tr><td>Attendance</td><td>05%</td></tr>
<tr><td>Final Lab Test</td><td>30%</td></tr>
<tr><td>Final Viva/ Final Lab Quiz Test</td><td>20%</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. J. N. Spillal, V. Kratika, Raj A, Basics of OS, UNIX and SHELL Programming, BPB Publication, 2017.
2. Abraham Silberschatz, Peter Bear Galvin & Greg Gagne “Operating System Concepts”, 8th edition, John Wiley & Sons.</td></tr>
<tr><td>Digital Learning Resources</td><td colspan="2"></td></tr>
</table>

DETAILED SYLLABUS (EXPERIMENTS):

Sl. No.	Name of Experiments (AT LEAST 10 EXPERIMENTS SHOULD BE DONE)	Duration in Hrs
1	Practice with UNIX commands(File management, Process Management, User Management, String searching and manipulation, Administrative Commands)	2
2	Basics of Shell Scripting, Conditional Blocks and Loop	2
3	Array, String, Function in Shell Script	
4	Process Creation using Fork and exec	2
5	Inter-process Communication using Named Pipe	2
6	Process Synchronization Using Semaphore	2
7	Simulation of CPU Scheduling Algorithms(FCFS, SJF, RR)	2
8	Simulation of Deadlock Prevention Algorithms(Banker's Algorithm)	2
9	Simulation of Page Replacement Algorithms(FIFO, LRU)	2
10	Simulation of Disk Scheduling Algorithms	2

COURSE DESCRIPTION:

Degree	B. Tech.
Level	Undergraduate
Branch	ELC (Electronics and Computer Engineering)
Semester	5^{th}
Subject Name	**Python Programming Laboratory**.
Course Type	Laboratory
Course Code	22ELC5PC03L
Category	**Professional Core**
Credit Point	1

<table>
<tr><td rowspan="4">Time Commitment</td><td>Lecture</td><td>05 Hours</td></tr>
<tr><td>Tutorial</td><td>Nil</td></tr>
<tr><td>Practice</td><td>20 Hours</td></tr>
<tr><td>Total</td><td>25 Hours</td></tr>
<tr><td>Recommended Background Knowledge/Course Pre-requisites</td><td colspan="2"></td></tr>
<tr><td>Subject Description</td><td colspan="2">.</td></tr>
<tr><td rowspan="2">Objectives and Outcomes</td><td colspan="2">Objectives:

The course should enable the students to:

1. To write, test, and debug simple Python programs.
2. To implement Python programs with conditionals and loops.
3. Use functions for structuring Python programs.
4. Represent compound data using Python lists, tuples, and dictionaries.
5. Read and write data from/to files in Python.</td></tr>
<tr><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:

1. Write, test, and debug simple Python programs.
2. Implement Python programs with conditionals and loops.
3. Develop Python programs step-wise by defining functions and calling them.
4. Use Python lists, tuples, dictionaries for representing compound data.
5. Read and write data from/to files in Python.</td></tr>
<tr><td rowspan="4">Assessment/ Evaluation</td><td>Lab Experiments</td><td>20%</td></tr>
<tr><td>Record Writing</td><td>10%</td></tr>
<tr><td>Behavior/ Attitude</td><td>05%</td></tr>
<tr><td>Quiz</td><td>10%</td></tr>
</table>

	Attendance	05%
	Final Lab Test	30%
	Final Viva/ Final Lab Quiz Test	20%
Prescribed Text Book(s)		
Digital Learning Resources		

DETAILED SYLLABUS (EXPERIMENTS):

Sl. No.	Name of Experiments (AT LEAST 10 EXPERIMENTS SHOULD BE DONE)	Duration in Hrs
1	Basic Python programming with selection and loop control statement.	2
2	Types of functions, lambda function, and use of recursion in Python programming.	2
3	Implementation of list, tuple, set, dictionary.	
4	Implementation of string using string inbuilt functions.	2
5	File handling operations using Python programming.	2
6	Implementation of real-world entities using the OOPs concept.	2
7	Implementation of inheritance, abstract class, and interfaces.	2
8	Implementation of operator overloading and method overriding.	2
9	Exception handling using Python.	2
10	Demonstration on NumPy and graph plotting using Matplotlib.	2