

**ELC Seventh Semester**

**Theory**

Sl. No.	Category	Subject Code	Subject Name	L-T-P	Credit
1	PCC	22ELC7PC01T	PCC11: Web Technology	3-0-0	3
2	PCC	22ELC7PC02T	PCC12: Computer Network and Data Communication	3-0-0	3
3	PEC	<b>Professional Elective-5:</b>			
		22ELC7PE01T	Software project management	3-0-0	3
		22ELC7PE02T	Embedded Real Time Systems		
	22ELC7PE03T	Radar Engineering			
4	PEC	<b>Professional Elective-6:</b>			
		22ELC7PE04T	VLSI Design Automation	3-0-0	3
		22ELC7PE05T	Mobile Computing		
	22ELC7PE06T	Wireless Communication Network			
5	OEC	<b>Open Elective-4 (For ECE Branch Students):</b>			
		22EE7OE01T	Energy Storage Systems	3-0-0	3
		22EE7OE02T/ 22EEE7OE01T	Energy Auditing and Management		
		22EEE7OE02T	Introduction to Biomedical Instrumentation		
		22ME7OE01T	Robotics (Introduction to Kinematics and Dynamics)		
		22ME7OE02T	Numerical Methods for Engineers		
		22CE7OE01T	Environmental Impact Assessment and Life Cycle Analysis		
		22CE7OE02T	Industrial Water Management and Disposal		
		<b>Open Elective-4 (To Other Branch Students):</b>			
	22ELC7OE01T	Principles of Mobile Communication			
	22ELC7OE02T	Internet of Things (IoT)			
<b>Total Credit (Theory)</b>					<b>15</b>
<b>Practical</b>					
1	PCC	22ELC7PC01L	<b>PCC Lab-11:</b> Web Technology	0-0-2	1
2	PCC	22ELC7PC02L	<b>PCC Lab-12:</b> Computer Network and Data Communication Lab	0-0-2	1
3	PSI	22ELC7PS01L	Minor Project	0-0-6	3
4	PSI	22ELC7PS02L	Summer Internship / Summer Training / MOOC Certification	0-0-2	1
5	HSMC	22CM7HS01L	Entrepreneurship Project	0-0-4	2

# Professional Core Course [PCC]

## COURSE DESCRIPTION: WEB TECHNOLOGY

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	<b>WEB TECHNOLOGY</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7PC01T</b>	
<b>Category</b>	PCC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	JAVA Programming, HTML and Scripting	
<b>Subject Description</b>	<p>The World Wide Web continues to provide a foundation for the development of a broad range of increasingly influential and strategic technologies, supporting a large variety of applications and services, both in the private and public sectors. There is a growing need for management and decision makers to gain a clearer understanding of the application development process, from planning through to deployment and maintenance.</p>	
<b>Objectives and Outcomes</b>	<p><b>Objectives:</b></p> <p>The course should enable the students to:</p> <ol style="list-style-type: none"> <li>1. To teach students the basics of server-side scripting using Server Scripts.</li> <li>2. To explain web application development procedures.</li> </ol>	

	<ol style="list-style-type: none"> <li>3. To convey Servlet technology for writing business logic.</li> <li>4. To facilitate students to connect to databases using JDBC.</li> </ol>	
	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand the concept of HTML, CSS and JAVA SCRIPTS and design a Web Page.</li> <li>2. Identify the difference between the JSP and Servlet.</li> <li>3. Design web application using MVC architecture.</li> <li>4. Apply JDBC and ODBC technologies to create database connectivity.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. Web Technologies, Uttam K Roy, Oxford University Press.</li> <li>2. The Complete Reference PHP – Steven Holzner, Tata McGraw-Hill</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. Web Programming, building internet applications, Chris Bates 2nd edition, Wiley Dremtech.</li> <li>2. Java Server Pages – Hans Bergsten, SPD O’Reilly.</li> <li>3. Java Script, D.Flanagan, O’Reilly, SPD.</li> <li>4. Beginning Web Programming-Jon Duckett WROX.</li> <li>5. Programming world wide web, R.W. Sebesta. Fourth Edition, Pearson.</li> <li>6. Internet and World Wide Web – How to program, Dietel and Nieto, Pearson.</li> </ol>	
<b>Digital Learning Resources</b>	Course Name	<u>Web Technologies</u>
	Course Link	<a href="https://www.youtube.com/watch?v=A7SqdkVl630&amp;list=PLbR6csVS4_bBw2ak07P9Hn9_0A9mP">https://www.youtube.com/watch?v=A7SqdkVl630&amp;list=PLbR6csVS4_bBw2ak07P9Hn9_0A9mP</a>
	Course Instructor	Prof. Madhukar, Krishna Engineering College Ghazibad

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

Course Outcomes	Course Outcome Statement	PO's / PEO's
<b>CO1</b>	Understand the concept of HTML, CSS and JAVA SCRIPTS and design a Web Page.	PO1, PO2/ PEO1, PEO3
<b>CO2</b>	Identify the difference between the JSP and Servlet.	PO1, PO2,PO3 / PEO1, PEO2, PEO3
<b>CO3</b>	Design web application using MVC architecture.	PO1, PO2,PO3,PO4,PO5 / PEO1, PEO2, PEO3
<b>CO4</b>	Apply JDBC and ODBC technologies to create database connectivity.	PO1, PO2, Po4, PO5/ PEO1, PEO2, PEO3

### DETAILED SYLLABUS:

Module No. 1	INTRODUCTION TO INTERNET	8 Hours
<p><b>INTRODUCTION TO INTERNET:</b> Evolution of Internet and www, WEB2.0 and WEB 3.0.            Internet Protocol -TCP/IP, UDP, Secure HTTP (HTTPS)            Internet Addressing Scheme – Ipv4 &amp; IPv6, Domain Name Server, and IP Addresses-Mapping.            Building Web Sites: Planning for designing Web pages, site navigation, model and structure of a Website, Web Servers, Web Browsers, Two Tier and Three Tier Web-Based Architecture.</p>		

Module No. 2	HTML and CSS	8Hrs.
<p>HTML and CSS: HTML – Basic HTML using images links, Lists, Tables, Frames, and Form elements for designing a website.            HTML5: Migration, New Elements, Semantics, Canvas, SVG, Google Maps, Multimedia, APIs            CSS: Different types of Style Sheets: Inline, document level, internal and external The class selector, div &amp; span tags. Change the properties like background images, colors, and manipulating texts, using fonts, borders and boxes, margins, padding lists, and positioning using CSS.            CSS3: Rounded Corners, Border Images, Gradients, Shadows, 2D and 3D Transforms, transitions, Animations, object-fit, Multiple Columns, Box Sizing.</p>		

<b>Module No. 3</b>	<b>Java Script and XML</b>	<b>6 Hrs.</b>
<p><b>Java Script and XML:</b> Java Script – Java Script Object Model, Data types, Variables, Expressions, Operators and Flow Control Popup Boxes, JavaScript Objects: Date, array, Boolean, math Event handlers – (on click, on submit, etc.), Document Object Model, Form validations. Simple AJAX applications. XML: Introduction to XML, Defining XML tags, their attributes and values, Document type definition, XML Schemas, Document Object model, XHTML Parsing XML Data - DOM and SAX parsers in java.</p>		

<b>Module No. 4</b>	<b>JAVA Applets, Servlets, and JDBC</b>	<b>8 Hrs.</b>
<p><b>JAVA Applets, Servlets, and JDBC:</b> Java Applet: Introduction to Java, Writing Java Applets, the Life cycle of the applet, design a login page using applets. Designing GUI using the applet. Introduction to Servlets: Lifecycle of a Servlets, deploying a Servlets, The Servlets API, Reading Servlets parameters, reading initialization parameters, Handling HTTP Request &amp; Responses, Using Cookies and sessions, connecting to a database using JDBC. Databases: Connection to the server, creating a database, selecting a database, listing table names creating a table, inserting data, altering tables, SQL queries, deleting database, deleting data and tables. Servlet communications: Servlet to DBMS communication using type-4 connection, Servlet to DBMC communication using JDBC connection pooling,</p>		

<b>Module No. 5</b>	<b>JSP: Introduction to JSP</b>	<b>6 Hrs.</b>
<p><b>JSP: Introduction to JSP:</b> The Anatomy of a JSP Page, JSP Processing, Declarations, Directives, Expressions, Code Snippets, implicit objects, Using Beans in JSP Pages, Using Cookies and session tracking, connecting to database in JSP. Programming with JDBC Creating a DATABASE (MS- ACCESS/ORACLE/MySQL (for Type-3 and Type-4 connection). Designing dynamic and interactive web pages using any one of the following Technologies:</p> <ul style="list-style-type: none"> <li>● Chrome Developer Tools.</li> <li>● jQuery.</li> <li>● Bootstrap</li> <li>● Angular.js.</li> </ul>		

## COURSE DESCRIPTION: COMPUTER NETWORK AND DATA COMMUNICATION

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	<b>COMPUTER NETWORK AND DATA COMMUNICATION</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7PC02T</b>	
<b>Category</b>	PCC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Communication Engineering, Digital electronics	
<b>Subject Description</b>	<p>This course introduces the fundamental concepts, architectures, protocols, and technologies used in computer networks and data communication systems. It explores how data is transmitted across different types of networks and how network protocols enable communication between devices and systems. Emphasis is placed on the OSI and TCP/IP models, data transmission methods, networking hardware, addressing schemes, and common networking services. The course also covers practical aspects of networking, including LAN design, IP addressing, routing, switching, and the basic configuration of network devices. Through theoretical understanding and hands-on practice, students will gain the foundational knowledge required for more advanced networking topics or certifications.</p>	
<b>Objectives</b>	<p><b>Objectives:</b></p> <p>The course should enable the students to:</p>	

<b>and Outcomes</b>	<ol style="list-style-type: none"> <li>1. Basic concepts on Computer communication and networks.</li> <li>2. develop an understanding of different components of computer networks, various protocols,</li> <li>3. To have detail knowledge of data communication in different layers and different standard protocols.</li> <li>4. To learn basic concepts of internetworking, addressing, and routing.</li> </ol>	
	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Evaluate various computer networking techniques and reference models along with physical layer.</li> <li>2. Describe the data link layer protocols with framing, flow control and error detection techniques along with wireless LAN, V-LAN and multiple access concepts.</li> <li>3. Utilize the basic concepts of IP protocols to build routing mechanisms and to design, implement of networks using transport layer protocol.</li> <li>4. To understand various applications of application layer protocol.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. B.A. Forouzan, <i>Data Communications and Networking</i>, 5<sup>th</sup>Edition, McGraw Hill Education, 2017, India.</li> <li>2. Andrew S. Tanenbaum, D. J. Wetherall <i>Computer Networks</i>, 5<sup>th</sup>Edition, Pearson Education India, 2013, India.</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. William Stallings <i>Data and Computer Communication</i>, 10th Edition, Pearson Education, 2017, India.</li> <li>2. James F. Kurose, Keith W. Ross <i>Computer Networking – A top down approach featuring the Internet</i>, 6th Edition, Pearson Education, 2017, India.</li> </ol>	
<b>Digital Learning Resources</b>	Course Name	Data Communication
	Course Link	<a href="https://nptel.ac.in/courses/106/105/106105082/">https://nptel.ac.in/courses/106/105/106105082/</a>

	Course Instructor	Prof. A. Pal, Dept. of Computer Science and Engineering, IIT Kharagpur.
	Course Name	Communication Networks
	Course Link	<a href="https://nptel.ac.in/courses/117/105/117105148/">https://nptel.ac.in/courses/117/105/117105148/</a>
	Course Instructor	Prof. Goutam Das, G.S. Sanyal School of Telecommunication, IIT Khargapur

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

Course Outcomes	Course Outcome Statement	PO's / PEO's
<b>CO1</b>	Evaluate various computer networking techniques and reference models along with physical layer.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO2</b>	Describe the data link layer protocols with framing, flow control and error detection techniques along with wireless LAN, V-LAN and multiple access concepts.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO3</b>	Utilize the basic concepts of IP protocols to build routing mechanisms and to design, implement of networks using transport layer protocol.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO4</b>	To understand various applications of application layer protocol.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

## DETAILED SYLLABUS:

<b>Module No. 1</b>		<b>(8 hours)</b>
<b>Introduction:</b> Data communication, Networks and types of networks, Protocol layering: TCP/IP protocol suite, Detailed study of all seven layers of the OSI model and their corresponding TCP/IP layers., Multiplexing: FDM, TDM, WDM, switching: Circuit-switched networks, Packet switching.		
<b>Module No. 2</b>		<b>(10 hours)</b>
<b>Data link layer:</b> Introduction, Link-layer addressing, Error Detection and Correction: Introduction, Data Link Control services, DLC protocols, HDLC, Media Access Control: Random access, controlled access.  <b>Wired LANs:</b> Ethernet protocol, standard Ethernet, Fast Ethernet, and Gigabit Ethernet. Bluetooth		
<b>Module No. 3</b>		<b>(8 hours)</b>
<b>Connecting devices:</b> Hubs, switches, routers, virtual LANs, Network Layer: Services, Packet switching, performance, IPV4 addresses, IPV6 addresses and protocols, transitions from IPV4 to IPV6, Basics of unicast routing and multicast routing		
<b>Module No. 4</b>		<b>(6 hours)</b>
<b>Transport Layer:</b> Connectionless and connection oriented protocols, Transport layer protocols, User datagram protocol, and transmission control protocol.		
<b>Module No. 5</b>		<b>(8 hours)</b>
<b>Application Layer:</b> Paradigms, WWW, HTTP, FTP, Telnet, DNS, SNMP, Multimedia		

Professional  
Elective  
Course  
[PEC]

## COURSE DESCRIPTION: SOFTWARE PROJECT MANAGEMENT

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	<b>SOFTWARE PROJECT MANAGEMENT</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	22ELC7PE01T	
<b>Category</b>	PEC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Exposure to software development activities	
<b>Subject Description</b>	This course provides an in depth examination of project management principles and modern software project management practices. Methods for managing and optimizing the software development process are discussed along with techniques for performing each phase of the systems development lifecycle. Portfolio management and the use and application of software project management tools are also discussed.	
<b>Objectives and Outcomes</b>	<p><b>Objectives:</b></p> <p>The course should enable the students to:</p> <ol style="list-style-type: none"> <li>1. To understand the Software Project Planning and Evaluation techniques.</li> <li>2. To plan and manage projects at each stage of the software development life cycle (SDLC).</li> </ol>	

	<ol style="list-style-type: none"> <li>3. To learn about the activity planning and control software deliverables.</li> <li>4. To develop skills to manage the various phases involved in project management and people management that support organization's strategic goals.</li> </ol>	
	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand Project Management principles while developing software.</li> <li>2. Gain extensive knowledge about the basic project management concepts, framework, process models and software estimation techniques.</li> <li>3. Define the checkpoints, project reporting structure, project progress and tracking mechanisms using project management principles.</li> <li>4. Learn staff selection process and the issues related to people management.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. Software Project Management (SIE), (Fifth Edition); Bob Hughes, Mike Cotterell, Rajib Mall; Tata McGraw-Hill Education Pvt. Ltd; 2011.</li> <li>2. Effective Project Management: Traditional, Agile, Extreme; Robert K. Wysocki; John Wiley &amp; Sons.; 2011.</li> <li>3. Software Project Management: A Unified Framework; The Addison-Wesley Object Technology; Walker Royce; 1998</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. Software Project Management in Practice; Pankaj Jalote; Pearson Education; 2005.</li> <li>2. Software Engineering: Always learning; Ian Sommerville; Pearson; 2015.</li> </ol>	

	<p>3. Software Engineering: A Practitioner's Approach; Roger Pressman; McGraw-Hill Education; 2014.</p> <p>4. Gopalaswamy Ramesh, "Managing Global Software Projects" – McGraw Hill Education (India), Fourteenth Reprint 2013.</p>	
<b>Digital Learning Resources</b>	Course Name	Software Project Management
	Course Link	<a href="https://archive.nptel.ac.in/courses/106/105/106105218/">https://archive.nptel.ac.in/courses/106/105/106105218/</a>
	Course Instructor	Prof. Rajib Mall, Dept. of CSE, IIT Kharagpur

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

Course Outcomes	Course Outcome Statement	PO's / PEO's
<b>CO1</b>	Understand Project Management principles while developing software.	PO1, PO2/ PEO1, PEO3
<b>CO2</b>	Gain extensive knowledge about the basic project management concepts, framework, process models and software estimation techniques.	PO1, PO2,PO3 / PEO1, PEO2, PEO3
<b>CO3</b>	Define the checkpoints, project reporting structure, project progress and tracking mechanisms using project management principles.	PO1, PO2,PO3,PO4,PO5 / PEO1, PEO2, PEO3
<b>CO4</b>	Learn staff selection process and the issues related to people management.	PO1, PO2, Po4, PO5/ PEO1, PEO2, PEO3

**DETAILED SYLLABUS:**

<b>Module No. 1</b>	<b>Introduction to Software Project Management</b>	<b>8 Hours</b>
<b>Introduction to Software Project Management:</b> Importance of Software Project Management, Software engineering problem ,and software product, software product attributes, Software Project Vs. other types of projects activities covered by SPM, Categorization of Software Projects, Setting objectives, Management Principles, Management Control, Project portfolio Management. Project management Cycle, SPM framework, Strategic program Management, Stepwise Project Planning.		

<b>Module No. 2</b>	<b>Project Life cycle and Estimation</b>	<b>8 Hours</b>
<b>Project Life cycle and Estimation:</b> Review: Software process and Process Models - Choice of Process models - Rapid Application development - Agile methods- Extreme Programming - SCRUM - Managing interactive processes; Cost-benefit analysis, cash flow forecasting, cost-benefit evaluation techniques, Function Point calculation.  Life cycle phases: Engineering and production stages, inception, Elaboration, construction, and and transition phases.  Artifacts of the process: The artifact sets, Management artifacts, Engineering artifacts, and and programmatic artifacts. Effort and Cost estimation techniques – COSMIC Full function points – COCOMO II – a Parametric Productivity Model.		

<b>Module No. 3</b>	<b>Activity planning and project management and Project Management in the Testing phase</b>	<b>8 Hours</b>
<b>Activity planning and project management:</b> Objectives of Activity planning, Project schedules, Activities, Sequencing and scheduling, Network Planning models, Forward Pass & Backward Pass techniques, Critical path (CPM) method, Risk Management : identification, Assessment, Monitoring, PERT technique.  <b>Project Management in the Testing phase:</b> Introduction, test scheduling, test types, issues, and management structures for testing, metrics for testing phase,		

<b>Module No. 4</b>	<b>Process instrumentation, Project Control and Staffing</b>	<b>6 Hours</b>
<b>Process instrumentation, Project Control and Staffing:</b> The seven core Metrics, Management indicators, quality indicators, life cycle expectations, pragmatic Software Metrics, Metrics automation.		

<b>Module No. 5</b>	<b>Framework for Management and control</b>	<b>6 Hours</b>
<b>Framework for Management and control:</b> Collection of data Project termination, Visualizing progress, Cost monitoring, Earned Value Analysis- Project tracking, Change control- Software Configuration Management, Contract Management.		

## COURSE DESCRIPTION: EMBEDDED REAL TIME SYSTEMS

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC(Electronics and Computer Engineering)	
<b>Semester</b>	7th	
<b>Subject Name</b>	<b>EMBEDDED REAL TIME SYSTEMS</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7PE02T</b>	
<b>Category</b>	PEC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Microprocessors, Operating Systems, Basic Embedded Systems	
<b>Subject Description</b>	<p>Embedded Real-Time Systems is an advanced course that focuses on the design, development, and analysis of real-time embedded systems used in mission-critical and time-sensitive applications. The course introduces the fundamental principles of embedded system architecture, real-time operating systems (RTOS), and embedded software development. Students will learn how to build time-deterministic systems through task scheduling, synchronization, interrupt handling, and hardware-software interfacing.</p> <p>This course also covers practical aspects of embedded systems such as interfacing peripherals, using industry-standard tools, and implementing real-time applications on platforms like ARM, Arduino, and Raspberry Pi. Through case studies and hands-on assignments, learners will gain experience in applying RTOS concepts and embedded system design techniques to real-world problems in domains such as automotive, healthcare, smart homes, and IoT.</p>	

<b>Objectives and Outcomes</b>	<b>Objectives:</b> The course should enable the students to: <ol style="list-style-type: none"> <li>1. Understand the architecture and components of embedded systems.</li> <li>2. Learn the architecture and programming of ARM processor</li> <li>3. Explore and analyze different real-time operating system (RTOS) concepts.</li> <li>4. Get the concepts of embedded hardware and firmware design</li> </ol>	
	<b>Outcomes:</b> Upon completion of this course, the student will be able to: <ol style="list-style-type: none"> <li>1. Describe the architecture and components of embedded and real-time systems.</li> <li>2. Learn the architecture and programming of ARM processor</li> <li>3. Explain the working of RTOS components such as scheduler, tasks, and inter-task communication.</li> <li>4. Design and develop embedded systems using integration techniques, development tools, and EDLC principles.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. Introduction to Embedded Systems, K V Shibu, TMH Private Limited, New Delhi,2009</li> <li>2. Embedded System Design” by SantanuChattopadhyay, 2nd edition, PHI</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. LylaB.Das, —Embedded Systems : An Integrated Approach  Pearson Education, 2013.</li> <li>2. Jonathan W.Valvano, —Embedded Microcomputer Systems Real Time Interfacing , Third Edition Cengage Learning, 2012.</li> <li>3. C.M. Krishna, Kang G. Shin, —Real-Time Systems , International Editions, McGraw Hill 1997</li> <li>4. K.V.K.K.Prasad, —Embedded Real-Time Systems: Concepts, Design &amp;</li> </ol>	

	Programming, Dream Tech Press, 2005.
<b>Digital Learning Resources</b>	Course: Embedded Systems Link: <a href="https://nptel.ac.in/courses/108105057">https://nptel.ac.in/courses/108105057</a> Prof. Rajib Mall, Prof. Amit Patra, Prof. A. Routray, IIT Kharagpur

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

<b>Course Outcomes</b>	<b>Course Outcome Statement</b>	<b>PO's / PEO's</b>
<b>CO1</b>	Describe the architecture and components of embedded and real-time systems.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO2</b>	Learn the architecture and programming of ARM processor	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO3</b>	Explain the working of RTOS components such as scheduler, tasks, and inter-task communication.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO4</b>	Design and develop embedded systems using integration techniques, development tools, and EDLC principles.	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

## DETAILED SYLLABUS:

<b>Module No. 1</b>	<b>Introduction to Embedded Systems</b>	<b>8 Hours</b>
<b>Introduction to Embedded Systems</b> :What is an Embedded System, Embedded Systems VS General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, The Typical Embedded System, Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components, PCB and Passive Components, Characteristics and Quality Attributes of Embedded Systems, Hardware Software Co-Design and Program Modeling, Fundamental Issues in Hardware Software Co-design		

<b>Module No. 2</b>	<b>Embedded Hardware Design and Development</b>	<b>8 Hours</b>
<b>Embedded Hardware Design and Development:</b> Analog Electronic Components, Digital Electronic Components, VLSI and Integrated Circuit Design, Electronic Design Automation (EDA) Tools,  <b>Embedded Firmware Design and Development:</b> Embedded Firmware Design Approaches Embedded Firmware Development Languages.		

<b>Module No. 3</b>	<b>ARM</b>	<b>6 Hours</b>
<b>ARM:</b> ARM pipeline, Instruction Set Architecture ISA: Registers, Data Processing Instructions, Data Transfer Instructions, Multiplication's instructions, Software interrupts, Conditional execution, branch instruction, Swap instruction, and THUMB instructions.		

<b>Module No. 4</b>	<b>Real-Time Operating System (RTOS) based Embedded System Design</b>	<b>6 Hours</b>
<b>Real-Time Operating System (RTOS) based Embedded System Design:</b> Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, <b>Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling:</b> Putting them Altogether , Task Communication, Task Synchronizations, Device Drivers, How to Choose an RTOS.		

Module No. 5	Design and Development of Embedded System	8 Hours
<p><b>Design and Development of Embedded System:</b> Integrating and Testing of Embedded Hardware and Firmware, Integration of Hardware and Firmware, Board Bring up. The Embedded System Development Environment: The Integrated Development Environment (IDE), Types of Files Generated on Cross-Compilation, Disassembler/ Decompiler, Simulators, Emulators and Debugging.</p> <p>The Embedded Product Development Life Cycle (EDLC): Definition and objective of EDLC, Different Phases of EDLC, EDLC Approaches</p>		

## COURSE DESCRIPTION: Radar Engineering

<b>Degree</b>	B. Tech.	
<b>Level</b>	Undergraduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	<b>Radar Engineering</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7PE03T</b>	
<b>Category</b>	<b>PEC</b>	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Basics of Communication Engineering	
<b>Subject Description</b>	<p>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.</p>	
<b>Objectives and Outcomes</b>	<p><b>Objectives:</b> The course should enable the students to:</p> <ol style="list-style-type: none"> <li>1. Identify basic radar systems and their fundamental components.</li> <li>2. Explain radar equations and principles of radar signal analysis.</li> <li>3. Use radar concepts to solve detection and range estimation problems.</li> <li>4. Analyze radar system performance and limitations in different scenarios.</li> </ol>	
	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Demonstrate an understanding of radar fundamentals and factors that influence the detection process.</li> <li>2. Differentiate radar types based on their operational principles and fields of application.</li> <li>3. Familiarize with radar displays and their applications in real-time scenarios.</li> </ol>	

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

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

<b>Course Outcomes</b>	<b>Course Outcome Statement</b>	<b>PO's / PEO's</b>
<b>CO1</b>	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.
<b>CO2</b>	Differentiate radar types based on their operational principles and fields of application	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO3</b>	Familiarize with radar displays and their applications in real-time scenarios	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.
<b>CO4</b>	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:**

<b>Module No. 1</b>	<b>Introduction to Radar</b>	<b>10 Hours</b>
<p><b>Introduction to Radar:</b></p> <p>Basic radar, maximum unambiguous range, building blocks of radar, simple form of radar equation, Block diagram of Radar transmitter, Radar frequencies. Applications to radar.</p> <p><b>Radar equation:</b></p> <p>Prediction of Range performance, minimum detectable signal, receiver noise, SNR. Radar Cross Section, transmitter power, PRF, range ambiguities, and system losses.</p>		

<b>Module No. 2</b>	<b>CW and FM-CW Radar</b>	<b>8 Hours</b>
<p><b>CW and Frequency Modulated Radar:</b></p> <p>Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-</p>		

zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar.

**FM-CW Radar:**

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

<b>Module No. 3</b>	<b>MTI and Pulse Doppler Radar</b>	<b>6 Hours</b>
<b>MTI and Pulse Doppler Radar:</b>  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.		

<b>Module No. 4</b>	<b>Tracking Radar</b>	<b>6 Hours</b>
<b>Tracking Radar:</b>  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.		

<b>Module No. 5</b>	<b>Radar Receiver and Modern Radars</b>	<b>6 Hours</b>
<b>Radar Receiver:</b> Block Diagram of Radar Receiver & Radar Displays- A-scope and PPI. <b>Modern Radars:</b> Height Finding Radars, Synthetic Aperture Radar.		

## COURSE DESCRIPTION: VLSI Design Automation

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7th	
<b>Subject Name</b>	<b>VLSI Design Automation</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7PE04T</b>	
<b>Category</b>	PEC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Digital logic design fundamentals, basic understanding of hardware description languages (Verilog), computer architecture concepts, and introductory knowledge of integrated circuit design principles.	
<b>Subject Description</b>	VLSI Design Automation covers the complete design methodology and flow for integrated circuits, from architectural design through physical implementation, with emphasis on design optimization techniques for area, timing, and power. The course focuses extensively on SystemVerilog for modeling sequential circuits, advanced data types, procedural programming constructs, and testbench development for verification of complex digital systems.	
<b>Objectives and Outcomes</b>	<b>Objectives:</b> The course should enable the students to: <ol style="list-style-type: none"><li>1) Understand VLSI design flow, synthesis, and optimization for area, timing, and power.</li><li>2) Master sequential circuit modeling with FSMs, timing analysis, and</li></ol>	

	blocking statements. 3) Develop SystemVerilog proficiency with data types, arrays, and procedural constructs. 4) Create efficient testbenches using SystemVerilog routines and interface constructs.	
	<b>Outcomes:</b> Upon completion of this course, the student will be able to: <ol style="list-style-type: none"> <li>1) Design and optimize VLSI circuits using complete design flow methodology and synthesis techniques.</li> <li>2) Implement sequential circuits with proper FSM design, timing analysis, and statement usage.</li> <li>3) Program complex digital systems using SystemVerilog data types, arrays, and procedural statements.</li> <li>4) Develop comprehensive testbenches for verification using SystemVerilog routines and interfaces.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. Samir Palnitkar “Verilog HDL: A Guide to Digital Design and Synthesis”, Prentice Hall.</li> <li>2. Chris Spears, “ System Verilog for Verification”, Springer, 2nd Edition</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. H.Gerez, “Algorithms for VLSI Design Automation”, John Wiley, 1999.</li> <li>2. Z. Dr Mark, “Digital System Design with System Verilog”, Pearson, 2010.</li> <li>3. S.Sutherland, S. Davidmann&amp; P. Flake, “System Verilog for Design”, 2nd Edition, Springer, 2006.</li> <li>4. Essential Electronics design Automation (EDA)- Mark D.Birnbaum, Prentice Hall,2004</li> </ol>	

	5. M.J.S.Smith, “Application Specific Integrated Circuits”,Pearson, 2008		
	6. Electronics Design Automation: Synthesis, verification & Test (System on Silicon)- LaungTerng Wang, Morgan Kaufmann,2009		
<b>Digital Learning Resources</b>	Course Name	Electronic Design and Automation	
	Course Link	<u><a href="https://nptel.ac.in/courses/106/105/106105083/">NPTEL : Computer Science and Engineering -Electronic Design and Automationhttps://nptel.ac.in/courses/106/105/106105083/</a></u>	
	Course Instructor	Prof.I.Sengupta, IIT Kharagpur	

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

<b>Course Outcomes</b>	<b>Course Outcome Statement</b>	<b>PO's / PEO's</b>
<b>CO1</b>	Design and optimize VLSI circuits using complete design flow methodology and synthesis techniques.	PO1, PO2, PO4, PO5, PO7, PO10, PO11, PO12, PEO1, PEO2.
<b>CO2</b>	Implement sequential circuits with proper FSM design, timing analysis, and statement usage.	PO1, PO2, PO3, PO4, PO7, PO8, PO10, PO12, PEO1, PEO2.
<b>CO3</b>	Program complex digital systems using SystemVerilog data types, arrays, and procedural statements.	PO1, PO2, PO4, PO5, PO8, PO10, PO11, PEO1, PEO2.
<b>CO4</b>	Develop comprehensive testbenches for verification using SystemVerilog routines and interfaces.	PO1, PO2, PO3, PO4, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

## DETAILED SYLLABUS:

<b>Module No. 1</b>	Design Methodology	<b>(6 Hrs.)</b>
.Design Methodology: Design Flow-Architecture, Functional design and verification, Synthesis, Physical design. Design Optimization-Area, Timing and Power, System representation.		
<b>Module No. 2</b>	Modelling sequential circuits	<b>( 10 Hrs.)</b>
Modelling sequential circuits: Latches and Flip-flops, counters, mealy and Moore FSM, shifters, sequential circuit using FSM,Blocking and non-blocking statements, Static timing analysis		
<b>Module No. 3</b>	System Verilog- Introduction	<b>(10 Hrs.)</b>
System Verilog- Introduction, Design hierarchy, Data types: Built-in data types, Fixed-size arrays, Dynamic arrays, Queues, Associative arrays, Array methods, Choosing a storage type, Creating new types with typedef.		
<b>Module No. 4</b>	System Verilog Procedural statements	<b>(8 Hrs.)</b>
Creating user-defined structures, Type conversion, Enumerated types, Constants strings, Expression width. System Verilog Procedural statements and routines: Procedural statements, tasks, functions and void functions.		
<b>Module No. 5</b>	System Verilog routines	<b>(6 Hrs.)</b>
Routine arguments, Returning from a routine, Local data storage, Time values Connecting the testbench and design: Separating the testbench and design, Interface constructs.		

## COURSE DESCRIPTION: MOBILE COMPUTING

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	<b>MOBILE COMPUTING</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7PE05T</b>	
<b>Category</b>	PEC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Cellular System, Mobile Communication, Computer Network	
<b>Subject Description</b>	This course covers mobile computing architectures, wireless communication standards, and mobility management. Topics include GSM, GPRS, WLAN (IEEE 802.11), Mobile IP, MANET protocols, Bluetooth, WAP, WLL, and satellite systems, with focus on protocol design, handoff, and tunneling mechanisms.	
<b>Objectives and Outcomes</b>	<p><b>Objectives:</b></p> <p>The course should enable the students to:</p> <ol style="list-style-type: none"> <li>1. Analyze wireless communication infrastructure with respect to mobility, scalability, energy efficiency, and security in wireless networks.</li> <li>2. Demonstrate understanding of mobile network architecture, including mobility management, resource allocation, and handoff</li> </ol>	

	<p>strategies.</p> <ol style="list-style-type: none"> <li>3. Explain the principles and standards of WLANs and cellular technologies, and understand the transition toward 3G and beyond.</li> <li>4. Describe various mobile satellite communication systems and evaluate their role in global data communication.</li> </ol>	
	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. To understand the infrastructure to develop wireless communication systems and analyses security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.</li> <li>2. To understand network architecture and its components. Gain knowledge of mobility management, resources management and handoff management concepts</li> <li>3. To aware the working principles of different wireless LAN, 3G and its standards. • Understand migration to 3G Technologies.</li> <li>4. To understand different types of mobile satellite network and their aspect of data communication</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. P.K. Patra, S.K. Dash: Mobile Computing, Scitech Publications.</li> <li>2. J. Schiller: Mobile Communication, Pearson Education</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. Mobile Computing by Rajkamal, Oxford University Press.</li> <li>2. Mobile Computing by Talukdar, Tata McGraw-Hill Education.</li> <li>3. Principles of Mobile Computing by Hansmann, Merk, 2nd Edition, Springer</li> </ol>	
<b>Digital Learning Resources</b>	<p>Course Name: Mobile computing Course Link: NPTEL:</p>	

	<a href="https://www.youtube.com/playlist?list=PLsK7K7rfGYke2ZfFugu2cppvNHNrjdD-u">https://www.youtube.com/playlist?list=PLsK7K7rfGYke2ZfFugu2cppvNHNrjdD-u</a> Course Instructor: Shadab Ghazali, IIT Kharagpur
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### CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	To understand the infrastructure to develop wireless communication systems and analyse security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.	PO1, PO2/ PEO1, PEO3
CO2	To understand network architecture and its components. Gain knowledge of mobility management, resources management and handoff management concepts	PO1, PO2 / PEO1, PEO3
CO3	To aware the working principles of different wireless LAN, 3G and its standards. • Understand migration to 3G Technologies.	PO1, PO5 / PEO1, PEO2, PEO3
CO4	To understand different types of mobile satellite network and their aspect of data communication	PO1, PO2/ PEO1, PEO2, PEO3

### DETAILED SYLLABUS:

<b>Module No. 1</b>	<b>Mobile Computing &amp; Cellular Networks</b>	<b>12 Hrs.</b>
<p><b>Introduction to Mobile Computing:</b> Introduction, mobile computing architecture, simplified reference model, evaluation of wireless technology.</p> <p><b>Personal Communications Services (PCS):</b> Features, PCS Network Architecture, Mobility Management.</p> <p><b>Global System for Mobile Communication (GSM):</b> Mobile services, System architecture, Radio interface, GSM Channels, Localization and calling, Handoff, Network signalling</p>		

<b>Module No. 2</b>	<b>Packet Data and Wireless LANs</b>	<b>8 Hrs.</b>
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**General Packet Radio Services (GPRS):** GPRS Architecture, GPRS Network Nodes, GPRS-Data Routing.

**WLANs (Wireless LANs):** Wireless Applications and Standards, IEEE 802.11WLAN Technologies 202.11 standards, services, IEEE 202.11- Network Architecture, protocol Architecture.

**Wireless Enterprise Networks:** Introduction to Virtual Networks, Blue tooth- User Scenarios, Architecture, Protocol stack, Bluetooth Connection Establishment.

<b>Module No. 3</b>	<b>Mobile IP and Ad-hoc Networks</b>	<b>6 Hrs.</b>
<b>Mobile IP:</b> Goals, Entities and terminology, IP Packet Delivery, Registration, Tunnelling and Encapsulation, Reverse tunneling.		
<b>Mobile ad-hoc networks:</b> Overview, properties of MANET, Routing and various routing Algorithm, Adhoc routing protocols: DSDV, CGSR, DSR.		

<b>Module No. 4</b>	<b>Wireless Application Protocol (WAP)</b>	<b>6 Hrs.</b>
<b>Wireless Application Protocol (WAP):</b> WAP Forum, the Mobile Internet Standard, WAP Architecture, WAP Gateway and Protocols, Wireless Markup Languages (WML), WAP push Pull Architecture.		
<b>Wireless Local Loop (WLL):</b> Introduction to WLL Architecture, wireless Local Loop Technologies		

<b>Module No. 5</b>	<b>Global Mobile Satellite Systems</b>	<b>4 Hrs.</b>
<b>Global Mobile Satellite Systems:</b> Types of satellite systems, Satellite system architecture, Case studies of the IRIDIUM, ICO and GLOBALSTAR systems		

**COURSE DESCRIPTION: Wireless Communication Network**

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	<b>Wireless Communication Network</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7PE06T</b>	
<b>Category</b>	PEC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Cellular System, Mobile Communication, Computer Network	
<b>Subject Description</b>	A wireless communication network connects devices and computers without using network cables. Devices use radio communications to send data between each other. Devices can communicate directly with other wireless devices, or connect to an existing network through a wireless AP.	
<b>Objectives and Outcomes</b>	<b>Objectives:</b> The course should enable the students to: <ol style="list-style-type: none"><li>1. An understanding on system architecture, functioning and various standards in cellular communication.</li><li>2. An understanding on signal propagation in cellular environment.</li><li>3. An ability to explain multiple access techniques for Wireless Communication.</li><li>4. An understanding on architecture, functioning, protocols, capabilities and application of various wireless communication networks.</li></ol>	

	<p><b>Outcomes:</b>  Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Describe the cellular concept and analyze capacity improvement techniques.</li> <li>2. Mathematically analyze propagation mechanisms in wireless mobile radio.</li> <li>3. Analyze and examine the multiple access techniques and its application in wireless communication.</li> <li>4. Demonstrate an understanding on architecture, functioning, protocols, capabilities and application of various wireless communication networks.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. V K Garg, <i>Wireless Communication and Networking, Essential Reading</i>, Morgan Kaufman Publishers India; 2008.</li> <li>2. T.S. Rappaport, <i>Wireless Communications: Principles and practice</i>, 2<sup>nd</sup> Ed, Pearson, 2018.</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. Andreas F. Molisch, <i>Wireless Communication</i>, 2<sup>nd</sup> Edition, John Wiley and Sons Ltd., India, 2011.</li> <li>2. A Goldsmith, <i>Wireless communication</i>, Cambridge University Press, India, 2009.</li> <li>3. Michel DaoudYacoub, <i>Wireless Technology: Protocols, Standards, and Techniques</i>, CRC Press, 2002.</li> </ol>	
<b>Digital Learning Resources</b>	<p>Course Name: Introduction to Wireless and Cellular Communications</p> <p>Course Link: <a href="https://nptel.ac.in/courses/106/106/106106167/">https://nptel.ac.in/courses/106/106/106106167/</a></p> <p>Course Instructor: Prof. David Koilpillai, Dept. Electrical Engineering, IIT Madras</p>	

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

Course Outcomes	Course Outcome Statement	PO's / PEO's
<b>CO1</b>	Describe the cellular concept and analyze capacity improvement techniques.	PO1, PO2/ PEO1, PEO3
<b>CO2</b>	Mathematically analyze propagation mechanisms in wireless mobile radio.	PO1, PO2 / PEO1, PEO3
<b>CO3</b>	Analyze and examine the multiple access techniques and its application in wireless communication.	PO1, PO5 / PEO1, PEO2, PEO3
<b>CO4</b>	Demonstrate an understanding on architecture, functioning.	PO1, PO2/ PEO1, PEO2, PEO3

### DETAILED SYLLABUS:

<b>Module No. 1</b>	<b>Overview of wireless systems and Cellular concepts:</b>	<b>8 Hrs.</b>
Introduction, frequency reuse, channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and grade of service, Improving coverage and capacity in cellular system.		

<b>Module No. 2</b>	<b>Radio propagation and path-loss models</b>	<b>6 Hrs.</b>
Introduction, free-space attenuation, attenuation over reflecting surface, radio wave propagation, characteristics of wireless channel, signal fading characteristics, Level crossing rate and average fade duration.		

<b>Module No. 3</b>	<b>Multiple access techniques for Wireless Communication</b>	<b>6 Hrs.</b>
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Introduction, FDMA, TDMA, Spread spectrum multiple access, space division multiple access, Packet radio, capacity of cellular system.

<b>Module No. 4</b>	<b>Wireless Wide-Area Network</b>	<b>8 Hrs.</b>
Introduction, WWAN subsystem entities, Logical channels, Channel and frame structure, Speech processing, power levels in mobile stations.		
Wireless application protocol: Introduction, WAP and WWW, the WAP programming model, WAP architecture, advantages and disadvantages, applications.		

<b>Module No. 5</b>	<b>Wireless Personal Area Network</b>	<b>8 Hrs.</b>
WPAN, Bluetooth - protocol stack, link types, security, network connection establishment, error correction, network topology, applications. Wireless Local Area Network: Introduction, topologies, WLAN technologies, IEEE 802.11 WLAN, WiMAX.		

Open Elective  
Course [OEC]  
offered by ELC to  
other branch  
students

**COURSE DESCRIPTION: Principles of Mobile Communication**

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7th	
<b>Subject Name</b>	<b>Principles of Mobile Communication</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7OE01T</b>	
<b>Category</b>	OEC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Basic knowledge of basic electronics digital communication, electromagnetic wave propagation, and signal processing is recommended.	
<b>Subject Description</b>	This course provides a comprehensive understanding of cellular and mobile communication systems, covering cellular architecture, radio propagation models, wireless system evolution, multiple access techniques, and spread spectrum technologies essential for modern wireless communication networks.	
<b>Objectives and Outcomes</b>	<b>Objectives:</b> <ol style="list-style-type: none"><li>1. The basic cellular concepts and capacity enhancement techniques like sectoring, cell splitting, microcell, picocell etc.</li><li>2. Analyze various channel models and fading characteristics.</li><li>3. The principles and applications of various multiple access techniques and compare them.</li><li>4. The principles and applications of various digital modulation techniques used in mobile communication.</li></ol>	

	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Identify and discuss the fundamental operational and design problems of cellular mobile communication systems.</li> <li>2. Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.</li> <li>3. Explore various wireless mobile communication standards and analyze their system performance.</li> <li>4. Analyze various multiple access techniques and compare their system performance in terms of capacity and spectral efficiency.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. V K Garg <i>Wireless Communication and Networking: Essential Reading</i>, Morgan Kaufman Publishers, India, 2008.</li> <li>2. T S Rappaport, <i>Wireless Communications</i>, 2<sup>nd</sup> Edition, Pearson Education, India, 2010.</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. Upena Dalal and Manoj K. Shukla, <i>Wireless and Mobile Communication</i>, Oxford University Press, India, 2016.</li> <li>2. W C Y Lee, <i>Mobile Communication Engineering – Theory and Applications</i>, 2<sup>nd</sup> Edition, McGraw Hill Education, India, 2017.</li> <li>3. A Goldsmith, <i>Wireless communication</i>, Cambridge University Press, India, 2009.</li> </ol>	
<b>Digital Learning Resources</b>	<a href="https://nptel.ac.in/courses/117/102/117102062/">https://nptel.ac.in/courses/117/102/117102062/</a>	

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

Course Outcomes	Course Outcome Statement	PO's / PEO's
<b>CO1</b>	Identify and discuss the fundamental operational and design problems of cellular mobile communication systems.	1,2
<b>CO2</b>	Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.	3,4
<b>CO3</b>	Explore various wireless mobile communication standards and analyze their system performance.	5
<b>CO4</b>	Analyze various multiple access techniques and compare their system performance in terms of capacity and spectral efficiency.	5

#### DETAILED SYLLABUS:

Module No. 1	Fundamentals of Cellular Communications	8 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 Reuse Pattern; Microcell & Picocell Zone Concept.		

Module No. 2	Radio Propagation Models	8 Hours
<p><b>Large Scale Propagation:</b> Introduction, Free Space Propagation Model; Basic propagation mechanisms, Ground Reflection (2-ray) Model; Free-space Attenuation, Attenuation over Reflecting Surfaces; Outdoor propagation and Indoor Propagation Path Loss Models.</p> <p><b>Small Scale Propagation:</b> small scale multi path propagation; Characteristics of Wireless Channel, Parameters of multi path channels; types of multi path fading.</p>		

<b>Module No. 3</b>	<b>Mobile Wireless Communication Systems</b>	<b>8 Hours</b>
Evolution of cellular communication system, Cellular Communications from 1G to 3G, Road map for higher data rate capability in 3G, Wireless 4G Systems-vision, 4G Features and Challenges, Future Wireless Networks: GSM- System architecture, Radio interface, GSM Channels, Localization and calling.		

<b>Module No. 4</b>	<b>Multiple Access Techniques</b>	
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.		

<b>Module No. 5</b>	<b>Spread Spectrum and Equalization Techniques</b>	
Spread Spectrum(SS) Systems- Introduction, Concept of Spread Spectrum, System Processing Gain, Frequency-Hopping Spread Spectrum Systems.		

## COURSE DESCRIPTION: INTERNET OF THINGS (OE)

<b>Degree</b>	B. Tech.	
<b>Level</b>	Graduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	<b>INTERNET OF THINGS</b>	
<b>Course Type</b>	Theory	
<b>Course Code</b>	<b>22ELC7OE02T</b>	
<b>Category</b>	OEC	
<b>Credit Point</b>	3	
<b>Time Commitment</b>	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
<b>Recommended Background Knowledge</b>	Basic Computer Networking, fundamental of communication	
<b>Subject Description</b>	This course introduces the architecture, protocols, and design methodologies of IoT systems. It covers M2M communication, device-level programming using Raspberry Pi, data analytics, and Industry 4.0 concepts, with applications in smart infrastructure, energy, and automation.	
<b>Objectives and Outcomes</b>	<p><b>Objectives:</b></p> <p>The course should enable the students to:</p> <ol style="list-style-type: none"> <li>1. To stand the fundamental architecture, communication models, and challenges of IoT systems.</li> <li>2. Explore the role of IoT across industrial domains and smart infrastructure.</li> <li>3. To learn cloud, networking concepts, and communication technologies that support IoT.</li> <li>4. To study data analytics techniques, big data tools, and Industry 4.0 enabling services.</li> </ol>	

	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Describe the architecture, characteristics, and communication protocols of IoT systems.</li> <li>2. Analyze real-world and industrial applications of IoT across various domains.</li> <li>3. Apply IoT platform design methodologies and integrate basic hardware components.</li> <li>4. Utilize data analytics tools for IoT and explain the relevance of Industry 4.0 technologies.</li> </ol>	
<b>Assessment/ Evaluation</b>	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 %
<b>Prescribed Text Book(s)</b>	<ol style="list-style-type: none"> <li>1. VijayMadiseti, Arshdeep Bahga, “Internet of Things- A Hands-On-Approach”, Universities Press, 2015.</li> <li>2. David Hanes Atzor et.al, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, June 2017</li> </ol>	
<b>Reference Book(s)</b>	<ol style="list-style-type: none"> <li>1. Honbo Zhou,”The Internet of Things in the Cloud: A Middleware Perspective” — CRC Press, 2012.</li> <li>2. Luigi Atzor et.al, “The Internet of Things: A survey, “, Journal on Networks, Elsevier Publications, October 2010..</li> </ol>	
<b>Digital Learning Resources</b>	Course Name	Introduction to internet of things, NPTEL
	Course Link	<a href="https://archive.nptel.ac.in/courses/106/105/106105166/">https://archive.nptel.ac.in/courses/106/105/106105166/</a>
	Course Instructor	Prof. Sudip Misra, IIT Kharagpur

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

<b>Course Outcomes</b>	<b>Course Outcome Statement</b>	<b>PO's / PEO's</b>
<b>CO1</b>	Describe the architecture, characteristics, and communication protocols of IoT systems.	PO1, PO2/ PEO1, PEO3
<b>CO2</b>	Analyze real-world and industrial applications of IoT across various domains	PO1, PO2,PO3 / PEO1, PEO2, PEO3
<b>CO3</b>	Apply IoT platform design methodologies and integrate basic hardware components	PO1, PO2,PO3,PO4,PO5 / PEO1, PEO2, PEO3
<b>CO4</b>	Utilize data analytics tools for IoT and explain the relevance of Industry 4.0 technologies.	PO1, PO2, Po4, PO5/ PEO1, PEO2, PEO3

#### **DETAILED SYLLABUS:**

<b>Module No. 1</b>	<b>IoT Architecture, Design, and Domain Application</b>	<b>10 Hours</b>
<p><b>Introduction &amp; Concepts:</b> Definition &amp; Characteristics of IoT, IoT frameworks, Physical Design of IoT- Things in IoT, IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, IoT Levels &amp; Deployment Templates.</p> <p><b>Domain Specific IoTs:</b> Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health &amp; Life Style, Challenges and Issues.</p>		

<b>Module No. 2</b>	<b>IoT and M2M</b>	<b>8 Hrs.</b>
<p><b>IoT and M2M:</b> Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT- Software Defined Networking, Network Function Virtualization.</p>		

<b>Module No. 3</b>	<b>IoT Platform Design Methodology</b>	<b>6 Hrs.</b>

**IoT Platform Design Methodology:** Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device & Component Integration, Case study on IoT system: smart lightning, weather monitoring system.

<b>Module No. 4</b>	<b>IoT Physical Devices &amp; Endpoints</b>	<b>6Hrs.</b>
<p><b>IoT Physical Devices &amp; Endpoints:</b> What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces – Serial, SPI , I2C , Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi ,interfacing an LED and Switch with Raspberry Pi, Interfacing a Light Sensor (LDR) with Raspberry Pi.</p>		

<b>Module No. 5</b>	<b>IoT Analytics and Emerging Technologies</b>	<b>6 Hrs.</b>
<p><b>Data and Analytics for IoT:</b> Use of Big Data and Visualization in IoT, IoT Data Analytics Overview and Challenges, Big Data Analytics Tools and Technology.</p> <p><b>IoT &amp; Beyond Industry 4.0:</b> Industry 4.0 concepts, The Various Industrial Revolutions, , Internet of Everything, Overview of RFID, Overview of Android.</p>		

# Laboratory Course

**COURSE DESCRIPTION: COMPUTER NETWORK AND DATA COMMUNICAITON LABORATORY**

<b>Degree</b>	B. Tech.	
<b>Level</b>	Undergraduate	
<b>Branch</b>	ELC (Electronics and Computer Engineering)	
<b>Semester</b>	7 <sup>th</sup>	
<b>Subject Name</b>	COMPUTER NETWORK AND DATA COMMUNICAITON LABORATORY	
<b>Course Type</b>	Laboratory	
<b>Course Code</b>	22ELC7PC02L	
<b>Category</b>	PCC	
<b>Credit Point</b>	1	
<b>Time Commitment</b>	Lecture	05 Hours
	Tutorial	Nil
	Practice	20 Hours
	Total	25 Hours
<b>Recommended Background Knowledge</b>	Fundamentals of networking, IP addressing and subnetting, OSI and TCP/IP models, basic command line interface (CLI) skills.	
<b>Subject Description</b>	This lab course provides practical exposure to computer networking concepts through hands-on experiments. Students will work with LAN hardware, perform cabling, and use tools like Cisco Packet Tracer and NS2 to simulate real-world networks. The course includes network setup, router and VLAN configuration, subnetting, and analyzing data flow using different topologies. It also emphasizes IP addressing, network commands, and congestion analysis. By the end, students will be equipped to design, configure, and troubleshoot networks in simulated environments.	
<b>Objectives</b>	<p><b>Objectives:</b></p> <p>The course should enable the students to:</p>	

<b>and Outcomes</b>	<ol style="list-style-type: none"> <li>1. Gain a comprehensive understanding on data communication, layered architecture, and wireless network device concepts.</li> <li>2. Understand the various techniques used to access a shared channel in the network and IEEE specifications for LANs.</li> <li>3. Learn about different types of networking devices, backbone networks and Internet Protocol (IP) addressing.</li> <li>4. Explore the functions of network, transport, and application layer protocols.</li> </ol>	
	<p><b>Outcomes:</b> Upon completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Identify and implement different types of LAN cabling techniques and configure basic LAN setups using networking hardware and software tools.</li> <li>2. Apply basic network commands and IP configuration techniques for network setup and troubleshooting in real and simulated environments.</li> <li>3. Design and simulate different network topologies, including the use of routers, subnetting, and VLANs, using Packet Tracer and NS2.</li> <li>4. Analyze network performance using simulation tools by evaluating data transfer, congestion, and determining IP-related details programmatically.</li> </ol>	
<b>Assessment/ Evaluation</b>	Lab Experiments	20%
	Record Writing	10%
	Behavior/ Attitude	05%
	Quiz	10%
	Attendance	05%
	Final Lab Test	30%
	Final Viva/ Final Lab Quiz Test	20%

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

<b>Course Outcomes</b>	<b>Course Outcome Statement</b>	<b>PO's / PEO's</b>
<b>CO1</b>	Identify and implement different types of LAN cabling techniques and configure basic LAN setups using networking hardware and software tools.	PO1, PO2, PO3, PO4, PO5, PO12, PEO1, PEO2.
<b>CO2</b>	Apply basic network commands and IP configuration techniques for network setup and troubleshooting in real and simulated environments.	PO1, PO2, PO3, PO4, PO5, PO12, PEO1, PEO2.
<b>CO3</b>	Design and simulate different network topologies, including the use of routers, subnetting, and VLANs, using Packet Tracer and NS2.	PO1, PO2, PO3, PO4, PO5, PO9, PO12, PEO1, PEO2.
<b>CO4</b>	Analyze network performance using simulation tools by evaluating data transfer, congestion, and determining IP-related details programmatically.	PO1, PO2, PO3, PO4, PO5, PO9, PO12, PEO1, PEO2.

<b>Sl. No.</b>	<b>Name of Experiments</b>	<b>Duration in Hrs</b>
1	Design and Preparation of Ethernet LAN Cable Using RJ-45.	2
2	To study basic network commands and network configuration commands and understand IP addressing..	2
4	To study and configure a basic router setup using Packet Tracer.	2
5	To implement and configure a three-router topology using Packet Tracer simulator.	2
6	To perform subnetting and analyze network performance using Packet Tracer.	2
7	To study and configure Virtual LANs (VLANs) using Packet Tracer	2
8	To simulate and study the data transfer between two nodes using NS2 (Network Simulator 2).	2

9	To implement and study the performance of a star topology network using NS2.	2
10	To implement and study the performance of a ring topology network using NS2.	2
11	To simulate the transmission of ping and trace route messages in a network of 6 nodes and analyze packet loss due to congestion.	2
12	To Write a program to find out class of a given IP address, sub-net mask, first & last IP address of that subnet etc.	2
13	Implementation and Comparison of Data Transmission Techniques Using LoRa, Wi-Fi, and Bluetooth Protocols.	2
14	Implementation of Network Applications Using Wired Ethernet and Wireless Bluetooth Communication.	2
15	Socket Programming for Client-Server Communication Using HTTP Protocol	2