Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Program	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Semester-I
Course Code	1IC501
Course Name	Research Methodology and IPR

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	---	30	20	50	100
		Credits: 3			

Course Objectives

1	To prepare students for undergoing research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology.
2	To enable student interpret the results, propose theories, suggest possible/alternative solutions, solve, and prove the solution adapted–logically and analytically, conclude the research findings.
3	To impart knowledge to analyze critically the literature and publish research in conferences, journals and to expose students to research ethics, IPR and Patents

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Demonstrate** a research solution in respective engineering domain using appropriate Engineering research process and research methodology.	Apply
CO2	**Device** feasible solution to a research problem in respective engineering domain based on economic, social and legal aspects using appropriate research procedures and practices.	Analyze
CO3	**Write** research publication, Dissertation, IPR and patent document.	Create

Module	**Module Contents**	**Hours**
I	**Engineering Research Process** Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Definition, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	6
II	**Research Methodology** Problem statement formulation, resources identification for solution, Experimental and Analytical modelling, Simulations, Numerical and Statistical methods in engineering research. Hypothesis and its testing by different techniques: Z-test etc.,	6
III	**Research Methods** Uni and Multivariate Analysis: ANOVA, Design of Experiments/Taguchi Method, Regression Analysis. Software tools like spreadsheets. Processing and Analysis of Data: Processing Operations, Types of Analysis-Presentation and Interpretation of Data Editing, Classification and Tabulation-	7

	Interpretation. Analyse your results and draw conclusions.	
IV	**Research Practices** Effective literature studies approaches, critical analysis, Plagiarism, Research ethics, Mendeley - Reference Management Software. Research communication- Effective Technical Writing, Writing a research article for Journal/conference paper, Technical report, Dissertation/ Thesis report writing, Software used for report writing such as WORD, Latex etc. Presentation techniques for paper/report/seminar. Publishing article in Scopus/SCI/Web of science indexed journal or conference.	7
V	**Intellectual Property Rights (IPR)** Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Ownership of copyright, Term of copyright, Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. New developments in IPR, Traditional knowledge ,Various Case Studies.	7
VI	**Patents** Patent Rights: Scope of Patent Rights. Various Patent databases. Geographical Indications. Procedure for grants of patents, Patenting under PCT. Licensing and transfer of technology. Administration of Patent System. Introduction to International Scenario: WIPO, TRIPs, Patenting under PCT	6

Textbooks	
1	Kothari C. R, "Research Methodology", 2nd Edition, New Age International, 2004
2	Melville Stuart and Goddard Wayne, "Research Methodology: An Introduction for Science & Engineering Students" Juta and Company Ltd, 2000.
3	Kumar Ranjit, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications, 4th Ed.-2014.
References	
1	Merges Robert, Menell Peter, Lemley Mark, "Intellectual Property in New Technological Age", ASPEN Publishers, 2016.
2	Ramappa T., "Intellectual Property Rights Under WTO", S. Chand, 2008
3	Mayall, "Industrial Design", McGraw Hill, 1992.
4	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
5	Deepak Chopra and Neena Sondhi, Research Methodology : Concepts and cases, Vikas Publishing House, New Delhi
Useful Links	
1	NPTEL :: General - NOC:Introduction to Research
2	Introduction to Research - Course (nptel.ac.in)
3	Qualitative Research Methods And Research Writing - Course (nptel.ac.in)
4	https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview - Academic Research & Report Writing
5	https://www.scopus.com/search/form.uri?display=basic#basic
6	https://onlinecourses.nptel.ac.in/noc21_ge12/preview - Qualitative Research Methods And Research Writing
7	https://onlinecourses.nptel.ac.in/noc21_hs44/preview - Effective Writing
8	https://webofscienceacademy.clarivate.com/learn

9	https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview - Academic Research & Report Writing
10	https://nptel.ac.in/courses/121/106/121106007/
11	https://www.wipo.int/about-wipo/en/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	3	4	5	6
CO1	3		1			
CO2			2	3	2	
CO3		3		2		2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment canbe field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks inESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli
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AY 2024-25

Course Information

Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. I
Course Code	1EC501
Course Name	Statistical Signal Processing
Desired Requisites:	-

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	# Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	# Hrs/week	30	20	50	100
		Credits: #			

Course Objectives

1	To study the Random process and correlation in signal
2	Understand the various transformations and signal representation
3	To learn the Linear filtering and estimation model
4	To know the prediction and model for random processes

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Interpret the density function applicable to random processes	III
CO2	Construct the moment analysis and transformation to random processes.	V
CO3	Categorise the transformation and filtering for random processes	V
CO4	Develop the prediction models for random processes	V

Module	**Module Contents**	**Hours**
I	**Random Vectors and Processes** Random Vectors and Their characterization, Expectation and moments, The multivariate Gaussian Density Function, Linear transformation of Random Vectors, Reversal Operation for Random Vectors, Diagonlization of the correlation Matrix by a Unitary Transformation, Diagonlization of the correlation Matrix by a Triangular Decomposition, Random Signal and sequences, Simple Random Process, Markov Process, Gaussian Random Process	
II	**Second Moment Analysis** The Correlation and covariance functions, correlation and covariance matrices, cross-correlation and covariance, frequency and Transform Domain Description of Random Processes, Symmetry properties of Correlation and spectra for complex Random processes, The Discrete Karhunen Loeve Transform, White noise	

III	**Linear Transformation** Transformation by Linear System, Difference Equation Representation of Linear shift Invariant Transformations, Spectral Representation of Linear Shift Invariant Transformations, The Matched Fiter, Spectral Factorization and innovations representation of Random Processes, Transformation of Higher Order Moments,	
IV	**Estimation and Optimal Filtering** Estimation of Parameters, Estimation of First and Second Moments for a Random Process, Bayes Estimation of Random Variables, Linear Mean Square Estimation The Orthogonal Principle, Linear Predictive Filtering, General Optimal Filtering: FIR and IIR Case, Recursive Filtering, Decomposition	
V	**Linear Prediction** The Autoregressive Model, Linear Prediction for AR Processes, Backward Linear Prediction and the Anticausal Model, The Levinson, Recursion, Lattice Representation for the Prediction Error Filter, Partial Correlation Interpretation of the Reflection Coeffiecients, Minimum phase Property of the Prediction Error Flter, Schur Algorithm, Split Algorithm, Relations to Triangular Decomposition , Lattice Representation for the FIR Wiener Filter	
VI	**Linear Models and Spectrum Estimation** Linear Modeling of Random Processes, Estimation of Model Parameters from Data, Principles of Least Squares Prediction, ARMA Modeling, Least square methods, Classical Spectrum Estimation, Spectrum Estimation Based on Linear Models, Maximum Likelihood Spectrum Estimation, Subspace Methods: Estimate the Discrete Components.	

Textbooks	
1	Charles W. Therrien, "Discrete Random Signals and Statistical Signal Processing", Prentice Hall Signal Processing Series
2	Steven M. Kay , "Fundamentals of Statistical Signal Processing: Estimation Theory" , Prentice Hall, 1st edition, 1993, ISBN-13: 978-0133457117
3	
4	

References	
1	Monson H. Hayes, 'Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2002
2	J. G. Proakis et. al., Algorithms for Statistical Signal Processing, Pearson Education, 2002
3	
4	

Useful Links	
1	
2	

3	
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. I
Course Code	1EC502
Course Name	Embedded System Design
Desired Requisites:	Microprocessors / Microcontrollers, Computer Programming

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Understand ARM processor core architecture with several features of peripherals available on various embedded Cortex- M processors
2	Understand interrupts and its programming with peripherals
3	To explain need of RTOS and services provided by it.
4	To demonstrate services provided by RTOS and their usage

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Illustrate** Cortex M3 / M4 processor architecture and RTOS Concepts.	Understand
CO2	**Apply** programming skills to develop algorithm for peripherals and interrupts.	Apply
CO3	**Test** the given program or situation and suggest the solution or a better approach, or identify more correct program.	Evaluate
CO4	**Design** embedded applications by using Embedded C / RTOS programming	Create

Module	**Module Contents**	**Hours**
I	**ARM Cortex –M Architecture and Programming** ARM Cortex M3 / M4 Architecture, Registers, CPU status, Clock generation, Memory organization, Instruction Set, Programming model – Registers, Operating Modes, Embedded C Programming	5
II	**ARM Peripherals and Programming** On chip peripherals, GPIO, RTC, Watchdog, Timer, PWM, Memory, UART, I2C, I2S, and SPI , CAN BUS protocol, LIN bus protocol, Drivers for serial port communication	7
III	**Cortex M CPU Interrupts** Nested Vectored Interrupt Controller (NVIC), Vector table, Interrupt priorities, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor and Pendable Service Call, SYSTICK Timer, Interrupt Sequences, Exits, Tail Chaining, Interrupt Latency, Start-up files, initialization of peripherals interrupts, Interrupt routines programming	7

IV	**Real-time operating system concepts** Need of OS, Types of OS, Foreground/Background Systems, Pre-emptive and Non-Pre-emptive Kernels, Priority inversion, Deadlock, Task structure, RTOS initialization, Task stack, Task states and task state transitions. Creating and deleting a task, Task priority, Case studies of task-based applications	7
V	**Time and Event management in RTOS** Clock tick, delaying a task, resuming the delayed task, getting system time, case study of application based on time management	7
VI	**Inter-task Communication in RTOS** Need of Inter-task communication, Semaphore, Mailbox, Queues in RTOS. Internals of RTOS for managing tasks and Inter task communication, Case study of inter-task Communication	6

Textbooks	
1	Joseph Yiu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Newnes; 3rd edition
2	Yifeng Zhu, "Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C", E-Man Press LLC
3	Jean J. Labrosse, "MicroC/OS II: The Real Time Kernel" CMP books publication ISBN: 978-1578201037
4	Qing Li, Caroline Yao ,"Real-Time Concepts for Embedded Systems," Elsevier ISBN: 978-1578201242

References	
1	Steve furber, "ARM System-on-Chip Architecture", Pearson Education
2	Frank Vahid and Tony Givargis, "Embedded System Design", Wiley
3	www.micrium.com for uCOS-II related documents, tutorials, downloads.
4	www.nxp.com for processor specific documents.

Useful Links	
1	https://www.nxp.com/
2	https://www.arm.com/
3	https://bit.ly/3nSz3B0 (Texas Instruments RTOS user guide)
4	https://www.segger.com/products/rtos/embos/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				2		
CO3				2		
CO4						3
1: Low, 2: Medium, 3: High						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information

Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. I
Course Code	1EC503
Course Name	Advanced Digital Communication
Desired Requisites:	Digital Communication

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	Study the various Digital modulation schemes
2	Understand the digital receiver mechanism
3	Study various multichannel and multicarrier system
4	Understand the fading effect on receiver signal.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Design optimum receivers for digital modulation techniques	V
CO2	Illustrate the various modulation schemes from the point of view of bandwidth, circuit complexity and noise performance	IV
CO3	Design an equalizer in the context of band-limited linear filter channels	V
CO4	Analyse the effect of fading on received signal	IV

Module	**Module Contents**	**Hours**
I	**Digital Modulation Schemes** Representation of Digitally Modulated Signals, Memoryless Modulation Methods, Signaling Schemes with Memory, Power Spectrum of Digitally Modulated Signals	7
II	**Optimum Receivers for AWGN Channels** Waveform and Vector Channel Models, Waveform and Vector AWGN Channels, Optimal Detection and Error Probability for Band-Limited Signaling, Optimal Detection and Error Probability for Power-Limited Signaling, Optimal Detection in Presence of Uncertainty: Noncoherent Detection, A Comparison of Digital Signaling Methods, Lattices and Constellations Based on Lattices, Detection of Signaling Schemes with Memory, Optimum Receiver for CPM Signals, Performance Analysis for Wireline and Radio Communication Systems	7
III	**Carrier and Symbol Synchronization** Signal Parameter Estimation, Carrier Phase Estimation, Symbol Timing Estimation, Joint Estimation of Carrier Phase and Symbol Timing, Performance Characteristics of ML Estimators,	6

IV	**Digital Communication Through Band-Limited Channels** Characterization of Band-Limited Channels, Signal Design for Band-Limited Channels, Optimum Receiver for Channels with ISI and AWGN, Linear Equalization, Decision-Feedback Equalization, Reduced Complexity ML Detectors, Iterative Equalization and Decoding—Turbo Equalization, Adaptive Linear Equalizer	6
V	**Multichannel and Multicarrier Systems** Multichannel Digital Communications in AWGN Channels, **,** Multicarrier Communications, Single-Carrier Versus Multicarrier Modulation, Modulation and Demodulation in an OFDM System , Spectral Characteristics of Multicarrier Signals, Channel Coding Considerations in Multicarrier Modulation	6
VI	**Fading Channels** Characterization of Fading Multipath Channels, The Effect of Signal Characteristics on the Choice of a Channel Model, Frequency-Nonselective, Slowly Fading Channel, Diversity Techniques for Fading Multipath Channels, Signaling over a Frequency-Selective, Slowly Fading Channel: The RAKE Demodulator, Multicarrier Modulation (OFDM), Capacity of Fading Channels, Ergodic and Outage Capacity, Performance of Coded Systems In Fading Channels	7
Textbooks		
1	Proakis, John G., and Masoud Salehi., "Digital communications" 5Th Edtion (ISBN 978–0–07–295716–7), Published by McGraw-Hill, 2007	
2	Upamanyu Madhow, 'Fundamentals of Digital Communication', Cambridge University Press	
3		
References		
1	Simon Haykin: "Digital communications", Wiley Publications	
2	Bernard SKLAR: "Digital communications", Pearson	
3		
Useful Links		
1	http://www.nptel.ac.in/courses/117101051/	
2		

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. I
Course Code	1EC551
Course Name	Embedded System Design Lab
Desired Requisites:	Microprocessors / Microcontrollers, Computer Programming

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To use Cortex M3 / M4 processor architecture and its features
2	To learn ARM Cortex –M Architecture and Programming
3	To co-relate the RTOS theory with the RTOS implementation.
4	To provide exposure to industry applications and facilitate for writing applications using RTOS.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** programming skills to integrate hardware peripherals of ARM microcontroller.	Apply
CO2	**Test** programs for ARM microcontroller.	Analyze
CO3	**Implement** a given logic as an RTOS based application	Analyze
CO4	**Develop** and **demonstrate** small embedded systems using Embedded C / RTOS programming	Create

List of Experiments / Lab Activities/Topics

List of Lab Activities:

1. Introduction to Embedded C programming and software / hardware tools
2. GPIO Programming and External Peripheral Interfaces
3. Interrupt programming
4. Programming of Timer to develop applications
5. Programming of PWM and application of it
6. Programming of communication protocols
7. Demonstration of RTOS based application in keil micro vision
8. Writing of RTOS based application
9. Semaphore for managing shared resource and task synchronization
10. Demonstration of Clock tick and its effect of event timing in RTOS based systems.
11. Inter-task management for event synchronization
12. Develop an application using Embedded C / RTOS concepts

Textbooks

1	Joseph Yiu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Newnes; 3rd edition
2	Yifeng Zhu, "Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C", E-Man Press LLC
3	Jean J. Labrosse, "MicroC/OS II: The Real Time Kernel" CMP books publication ISBN: 978-1578201037

4	Qing Li, Caroline Yao ,"Real-Time Concepts for Embedded Systems," Elsevier ISBN: 978-1578201242
References	
1	Steve furber, "ARM System-on-Chip Architecture", Pearson Education
2	Frank Vahid and Tony Givargis, "Embedded System Design", Wiley
3	www.micrium.com for uCOS-II related documents, tutorials, downloads.
4	www.nxp.com for processor specific documents.
Useful Links	
1	https://www.nxp.com/
2	https://www.arm.com/
3	https://bit.ly/3nSz3B0 (Texas Instruments RTOS user guide)
4	https://www.segger.com/products/rtos/embos/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3					
CO2			3	2		
CO3			3	2		
CO4						2
1: Low, 2: Medium, 3: High						

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	FY M. Tech., Sem. I
Course Code	1EC552
Course Name	Advanced Digital Communication Laboratory
Desired Requisites:	Digital communication Lab

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	0 Hrs/ Week	30	30	40	100
		Credits: 1			

Course Objectives	
1	Study the various Digital modulation schemes
2	Understand the digital receiver mechanism
3	Study various multichannel and multicarrier system
4	Understand the fading effect on receiver signal.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Design optimum receivers for digital modulation techniques	V
CO2	Illustrate the various modulation schemes from the point of view of bandwidth, circuit complexity and noise performance	IV
CO3	Design an equalizer in the context of band-limited linear filter channels	V
CO4	Demonstrate the fading channel effect on signal	III

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

Simulation based experiments: (Matlab/Labview simulation)

1. Sampling & reconstruction of low pass signals
2. BPSK Modulation & detection
3. BER of BPSK in AWGN channel
4. QPSK generation & detection
5. BER of QPSK in AWGN channel
6. QAM generation & detection
7. 16 QAM constellation diagram
8. Generation of Nyquist-I pulse
9. Designing an equalizer in the context of baseband binary data transmission
10. OFDM generation and detection

Textbooks	
1	Proakis, John G., and Masoud Salehi., "Digital communications" 5Th Edtion (ISBN 978–0–07–295716–7), Published by McGraw-Hill, 2007
2	Upamanyu Madhow, 'Fundamentals of Digital Communication', Cambridge University Press

References	
1	Simon Haykin: “Digital communications”, Wiley Publications
2	Bernard SKLAR: “Digital communications”, Pearson
3	
Useful Links	
1	http://www.nptel.ac.in/courses/117101051/
2	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
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Assessment

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IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem.-I
Course Code	1EC511
Course Name	Digital VLSI Design
Desired Requisites:	Digital Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To develop the fundamental concepts in digital design.
2	To make differences between combinational and sequential circuits evident to students.
3	To motivate students learn implementation of digital circuits using HDL and PLD.
4	To teach students to develop digital design using VHDL code

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Apply the analytical expressions involving physical parameters, process parameters and electrical parameters to characterize the MOS transistors by taking into account the fundamental principles involved with MOS devices.	Apply
CO2	Analyze static and dynamic CMOS circuits numerically to compute the various device parameters and circuit performance parameters.	Analyze
CO3	Select an appropriate logic style to design submicron MOS transistor based circuits using logical, analytical and computational skills	Apply
CO4	Justify the architectures/schematics of datapath design taking into consideration the timing and power dissipation issues.	Justify

Module	**Module Contents**	**Hours**
I	MOS transistor theory, MOS under static conditions, Secondary effects, Technology Scaling.	4
II	CMOS inverter, Static and Dynamic behaviour of CMOS inverter, Power and Energy-Delay, Impact of technology scaling on inverter.	6
III	Combinational logic designs in CMOS (static CMOS and dynamic CMOS), Comparison of static and dynamic designs in CMOS.	6
IV	Sequential logic designs in CMOS, Static and dynamic latches and registers.	8
V	Timing Issues in Digital Circuits: Timing Classification, Synchronous Design (Clock skew, Jitter, Clock Distribution, Latch based clocking), Self-Timed Circuits Design, Synchronizers and arbiters, Using PLL for clock synchronization, DLL.	8
VI	Designing arithmetic building blocks, Designing fast adders, Designing fast multipliers), Designing other arithmetic building blocks.	7

Textbooks

1	"Digital Integrated Circuits", Rabey, Chandrakasan, Nikolic, Pearson Education
2	"Principles of CMOS VLSI Design", Neil Weste, Kamran Eshraghian, Addison Wesley/Pearson Education

3	
4	
5	
References	
1	"Essentials of VLSI Circuits and Systems", Kamran Eshraghian, Pucknell and Eshraghian, Prentice-Hall (India)
2	"CMOS Digital Integrated Circuits: Analysis and Design" , Kang, Leblebici, TATA McGraw Hill Publication
3	"CMOS VLSI Design", Neil Weste, David Harris, Ayan Banerjee, Pearson Education, 2008
4	
Useful Links	
1	https://nptel.ac.in/courses/108/105/108105113
2	https://nptel.ac.in/courses/117/106/117106086
3	
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1	1				
CO2		1	1	2		
CO3			1	2		
CO4	2	2				
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. I
Course Code	1EC512
Course Name	Advanced Digital Signal Processing
Desired Requisites:	Signals and Systems, Digital Signal Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	----	30	20	50	100
		Credits: 3			

Course Objectives	
1	To illustrate the concepts of Advanced Signal Processing
2	To explain the different techniques for design of filters and multirate systems
3	To enable the students for the design and development of Adaptive DSP systems

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Explain the basic and advanced signal processing concepts	Discuss
CO2	Design FIR and IIR filters with given specifications	Design
CO3	Analyse the various algorithms related with multirate DSP	Analyze
CO4	Illustrate adaptive signal processing algorithms	Demonstrate

Module	**Module Contents**	**Hours**
I	**Review of Digital Signal Processing** Discrete Time Signals and systems, LTI Systems, Basic Signal Processing Operations, Discrete Time Systems-Classification, impulse and step responses, phase and group delays. Time domain and frequency domain characterization of LTI discrete time systems, Z Transform, Transfer function	8
II	**DSP Structures** Block Diagram Representation, Equivalent Structures, Basic FIR Digital Filter Structures, Basic IIR Digital Filter Structures, All pass Filters, Tuneable IIR Digital Filters, IIR Tapped Cascaded Lattice Structures, FIR Cascaded Lattice Structures, Parallel All pass Realization of IIR Transfer Functions	6
III	**DFT Computation Techniques** DFT-Definition and properties, symmetry properties, Circular convolution, Computation of DFT, Decimation in time (DIT) and Decimation in Frequency (DIF) Fast Fourier transform (FFT) algorithms , Linear filtering using FFT-overlap add, overlap save methods, Goertzel Algorithm	6
IV	**Filter Design Technique** Bilinear Transformation Method of IIR Filter Design, Design of Low pass IIR Digital Filters, Design of High pass, Band pass and Band stop IIR Digital Filters, Spectral Transformations of IIR Filters, FIR Filter Design Based on Windowed series, Design of Digital Filters with Least-Mean-Square Error, Constrained Least-Square Design of FIR Digital Filters	8

V	**Multi-rate Signal Processing** The Basic Sample Rate Alteration Devices, Filters in Sampling Rate Alteration Systems, Multistage Design of Decimator and Interpolator, The Poly phase Decomposition, Arbitrary-Rate Sampling Rate Converter, Digital Filters Banks, Two-Channel Quadrature-Mirror Filter bank	6
VI	**Introduction to adaptive signal processing** Introduction to Adaptive Filters, Steepest descent technique, LMS algorithm-Convergence analysis, Learning curve, SVD	6
Textbooks		
1	Sanjit K. Mitra, "Digital Signal Processing – A Computer based approach", Tata McGraw-Hill, 4th Edition , 2013	
2	Bernard Widrow, Samuel D. Stearns "Adaptive Signal Processing,", Prentice-Hall, Englewood Cli, NJ, 1985	
References		
1	J. G. Proakis, Dimitris K Manolakis, "Advanced Digital Signal Processing Principals, Algorithms and Applications,", Pearson,2007	
Useful Links		
1	NPTEL Lectures	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2			
CO2						1
CO3				2		
CO4	2					
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem.-I
Course Code	1EC553
Course Name	Digital VLSI Design Lab
Desired Requisites:	Digital Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	**Demonstrate** the use of EDA tools for designing digital circuits.
2	**Demonstrate** Cadence flow (Schematic entry to simulation) for implementing CMOS digital circuits.
3	**Prepare** the students for executing an individual or group problem of medium complexity.
4	To **explain** the relevance of CMOS technology in implementing digital circuits.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Characterize** MOS transistor for input and output characteristics for given bias conditions and find out its channel length modulation parameter, body effect parameter, threshold voltage	Apply
CO2	**Design and Simulate** gates and simple functional blocks using Cadence tools and TSMC Design Rules for 180 nm devices. (Schematic design entry, layout design entry and HDL design entry)	Create
CO3	**Develop** simulatable and synthesizable Verilog code for digital circuits, and implement the designed architectures in FPGA using Xilinx ISE tool.	Apply

Module	**Module Contents**	**Hours**

	List of Lab Activities: **A:** Using cadence Design Tools: 1. NMOS and PMOS characterization 2. Implementation of CMOS inverter and its characterization for VTC and power 3. Implementation of 2-inpout NAND and NOR. Finding out rise time, fall time of the output and propagation. 4. Implementation of 1-bit full adder using carry-out of the stage to drive the sum output (28 transistor implementation) 5. Implementation of 2-input NAND and NOR gates using different logic styles and compare the performance parameters with complementary CMOS logic style a. Pseudo logic style b. Pass Transistor logic style c. Transmission gate logic style d. Differential cascade voltage switch logic e. Dynamic (precharge and evaluate) logic style 6. Implementation of transmission gate based full adder circuit 7. Implementation of four bit Manchester carry chain 8. Implementation of 4-bit barrel shifter using pass transistors **B:** Task/mini-project/research problem: For the last lab session which students will have to carry out a task for a period of at least six weeks it is recommended that: student can search or teacher can assign a course related medium complexity task to a group of student not exceeding two by defining the problem statement suitably.	

Textbooks	
1	"Digital Integrated Circuits", Rabey, Chandrakasan, Nikolic, Pearson Education
2	"Principles of CMOS VLSI Design", Neil Weste, Kamran Eshraghian, Addison Wesley/Pearson Education
3	
4	
5	
References	
1	"Essentials of VLSI Circuits and Systems", Kamran Eshraghian, Pucknell and Eshraghian, Prentice-Hall (India)
2	"CMOS Digital Integrated Circuits: Analysis and Design" , Kang, Leblebici, TATA McGraw Hill Publication
3	"CMOS VLSI Design", Neil Weste, David Harris, Ayan Banerjee, Pearson Education, 2008
4	
Useful Links	
1	https://nptel.ac.in/courses/108/105/108105113
2	https://nptel.ac.in/courses/117/106/117106086
3	
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1	1				
CO2			1	2		2
CO3	1					2
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. **IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%**				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

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Course Information	
Programme	M. Tech. (Electronics Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1EC554
Course Name	Advanced Digital Signal Processing Lab
Desired Requisites:	Digital Signal Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction		30	30	40	100
		Credits: 1			

Course Objectives

1	To make students familiar with the algorithms in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Revise basic concepts of DSP	State
CO2	Design digital filters to suit specific requirements for specific applications	Design
CO3	Apply signal processing for areas such as Image Processing	Compare
CO4	Study of DSP Processors	Understand

List of Experiments / Lab Activities/Topics

Experiments using MATLAB :

1. Generation and analysis of different signals in time and frequency domains.
2. Study and applications of different transforms
3. Design of Digital Filter: IIR, FIR.
4. Design of multi rate signal system
5. Introduction to DSK 6713 kit and CCS environment
6. Study of input/output, architecture of C6x processor
7. Digital filter design using DSK 6713
8. Implementation of DSP applications using DSK 6713

Textbooks

1	Sanjit K. Mitra, "Digital Signal Processing – A Computer based approach", Tata McGraw-Hill, 4th Edition , 2013
2	Bernard Widrow, Samuel D. Stearns "Adaptive Signal Processing,", Prentice-Hall, Englewood Cli, NJ, 1985

References

1	J. G. Proakis, Dimitris K Manolakis, "Advanced Digital Signal Processing Principals, Algorithms and Applications,", Pearson,2007
2	User manual of TMS320C6713

Useful Links

1	NPTEL Courses
2	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1	2	3	4	5	6
CO2			2			
CO3				2		
CO4						2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. I
Course Code	1EC513
Course Name	Embedded Linux Programming
Desired Requisites:	Basics of OS

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To make students familiar with installation and use of the embedded Linux operating system
2	To facilitate the students to learn the fundamentals of Linux as applied to embedded hardware
3	To give exposure to system design using Embedded Linux as per the industry trends
4	To understand different applications of Embedded Linux

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** knowledge of Linux OS for Linux administration	Apply
CO2	**Write** programs for peripherals such as GPIO /Keyboard / Serial port using Embedded Linux board.	Apply
CO3	**Test** multi-file, multi-threaded programs under Linux OS.	Evaluate
CO4	**Design** application for real time data system and basic image processing using Linux boards	Create

Module	**Module Contents**	**Hours**
I	**Introduction** Introduction to Linux, Linux Distributions, Open source Software, GPL, Facilities in Embedded Linux Boards used in Industry/Market, Care to take in handling the Linux boards, Development Setup for Embedded Linux, OS installation, Case studies of Embedded Linux Based Systems.	5
II	**Linux file system and commands** Linux File System, Permissions, CLI and Linux Shells, Linux Commands, Linux concepts, Shell Script, Linux commands for file and process management, Linux Programming, Multi-file C Programming Using make utility, Makefile, GNU debugger, Transferring files between systems**,** Kernel.	7
III	**Multithreading and Hardware Access** Threads and processes, Multithreaded C programming. EL hardware design issues, Case studies of hardware of frequently used interfaces, Communication with Embedded Linux board through network, Embedded Linux GPIO control using sysfs, wiringPi and python. Python libraries	7

IV	**Hardware Interfacing and Programming-I** Using on-board I2C, SPI, and UART capabilities, communicate between UART devices using both Linux tools and custom C or Python code, Interface to sensors using a serial communication protocol.	7
V	**Hardware Interfacing and Programming-II** Using Interrupt functionality on devices, USB Bluetooth adapter for the RPi and connect to it from a mobile device for the purpose of building a basic remote-control application. Using Wi-Fi and ZigBee along with Embedded Linux board.	7
VI	**Basic Image Processing on Embedded Linux** Camera interfacing to EL board, Capture image and video using Open CV to perform basic image processing on the RPi. Open CV to perform a computer vision face-detection task.	6

Textbooks	
1	Christopher Hallinan, "Embedded Linux Primer: A Practical Real-World Approach", Prentice Hall; 1st edition (September 28, 2006), ISBN 978-0137017836
2	Richard Stones, Neil Matthew, "Beginning Linux Programming", Wiley; Fourth edition (2008)
3	Felix Alvaro, "LINUX: Easy Linux For Beginners", Amazon.com
4	Gareth Halfacree, "THE OFFICIAL Raspberry Pi Beginner's Guide - How to use your new computer" , 4th Edition, Raspberry Pi press.

References	
1	P. Raghavan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications; 1 edition (December 21, 2005), ISBN: 978-0849340581 http://crashcourse.ca/introduction-Linux-kernel-programming-2nd-edition
2	http://crashcourse.ca/introduction-Linux-kernel-programming-2nd-edition
3	Karim Yaghmour, Jon Masters, Gilad Ben-Yossef, Philippe Gerum, "Building Embedded Linux Systems", O'Reilly Media; Second Edition (August 22, 2008) ISBN: 978-0596529680
4	Christopher Negus , "Linux Bible", 10th Edition, John Wiley & Sons, 8 Jun 2020

Useful Links	
1	https://jaycarlson.net/embedded-linux/
2	https://www.tutorialspoint.com/unix/index.htm
3	https://www.raspberrypi.com/
4	https://www.raspberrypi.org/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		2
CO3				2		2
CO4						2
1: Low, 2: Medium, 3: High						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem.-I
Course Code	1EC514
Course Name	Solid State Electronic Devices
Desired Requisites:	-

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To ***introduce*** the physics of semiconductor materials for understanding the device modeling of semiconductor devices.
2	To ***provide*** students with a sound understanding of existing semiconductor devices to give meaning to their studies of electronic circuits and systems.
3	To ***explain*** carrier transport phenomena in solids on the basis of energy band theory and Boltzmann transport equation which forms the basis of electrical characteristics of semiconductor devices.
4	To ***develop*** the concept of advanced MOS structures and nano-transistors.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Explain** the formation of bandgaps in solids, formation of depletion-diffusion layer capacitance in p-n junction diodes and characteristics of illuminated p-n junction, incoherent (LEDs) and coherent light sources (Lasers).	Understand
CO2	**Apply** suitable approximations and techniques to derive the physical model of semiconductor devices such as p-n junctions.	Apply
CO3	**Model** the operation of bipolar junction transistor in three regions (cut-off, linear and saturation) using Ebers Moll coupled diode model.	Apply
CO4	**Model** and characterize Metal oxide semiconductor junctions, MOSFETs and advanced MOSFET structures.	Apply

Module	**Module Contents**	**Hours**
I	**Semiconductor Physics**: Semiconductor materials, crystal lattices, growth of semiconductors, energy bands and charge carriers in semiconductors, carrier concentrations, drift of carriers in electric and magnetic fields, excess carriers in semiconductors, diffusion of carriers, diffusion current, drift current, recombination, Quasi Fermi level.	8
II	**p-n Junctions and Metal-Semiconductor Contacts:** Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, reverse bias breakdown, transient and ac conditions, metal semiconductor junction, heterojunctions.	7
III	**Field Effect Transistors:** JFET (characteristics), MOS capacitor (threshold voltage, C-V characteristics), MOSFET: I-V characteristics, equivalent circuits for the MOSFET, advanced MOSFET structures.	7

IV	**Bipolar Junction Transistors:** Fundamentals of BJT operation, BJT fabrication, minority carrier distributions and terminal currents, generalized biasing, Coupled-Diode model, charge control analysis; switching, drift in base region, base narrowing, avalanche breakdown, thermal effects, Kirk effect, frequency limitations.	7
V	**Optoelectronic Devices:** Photodiodes: I-V characteristics in an illuminated junction, Solar Cells, Photodetectors; LEDs, Semiconductor Lasers.	6
VI	**Integrated Circuits:** Monolithic device elements, CMOS process integration, charge transfer devices (charge-coupled device).	5

Textbooks	
1	B.G. Streetman, S. K. Banerjee, " Solid State Electronic Devices ", 7th edition, Pearson India Education Service Pvt. Ltd., 2017.
2	S. M. Sze, "Physics of Semiconductor Devices", 3rd Edition, Wiley, 2007.
3	
4	

References	
1	Donald. A. Neamen, "Semiconductor Physics and Devices: Basic Principles", 3rd Edition, McGraw Hill Higher Education, 2003.
2	M. S. Tyagi, Introduction to Semiconductor Materials and Devices, Wiley, 2008.
3	
4	

Useful Links	
1	https://nptel.ac.in/courses/108/107/108107142/
2	https://www.youtube.com/playlist?list=PLF178600D851B098F
3	https://www.youtube.com/playlist?list=PLgMDNELGJ1CaNcuuQv9xN07ZWkXE-wCGP
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1		3				
CO2	2					
CO3				2		
CO4						3
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem.-I
Course Code	1EC515
Course Name	Spread Spectrum Communication
Desired Requisites:	Digital Communication

Teaching Scheme		Examination Scheme (Marks)			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives	
1	To study the concepts of Spread Spectrum sequence system.
2	To understand the multiple access system required for spread spectrum communication.
3	To study the principle of detection pf spread spectrum signal.
4	To Study the fading types and its effect on the received signal.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Compute the optimum synchronization technique based on the problem definition	III
CO2	Develop model for the detection of received signal.	V
CO3	Design suitable CDMA signal and detection methods for reducing interference	V
CO4	Analyze the performance of spread spectrum in jamming environment	IV

Module	Module Contents	Hours
I	**Direct-Sequence Systems** Definitions and Concepts, Spreading Sequences and Waveforms, Systems with PSK Modulation, Quaternary Systems, Pulsed Interference, Despreading with Matched Filters, Rejection of Narrowband Interference,	7
II	**Frequency-Hopping Systems** Concepts and Characteristics, Modulations, Codes for Partial-Band Interference, Frequency Synthesizers	7
III	**Code Synchronization** Acquisition of Spreading Sequences, Serial-Search Acquisition, Acquisition Correlator, Code Tracking, Frequency-Hopping Patterns,	6
IV	**Fading of Wireless Communications** Path Loss, Shadowing, and Fading, Time-Selective Fading, Frequency-Selective Fading, Diversity for Fading Channels, Rake Receiver, Error-Control Codes, Diversity and Spread Spectrum	6
V	**Code-Division Multiple Access** Spreading Sequences for DS/CDMA, Systems with Random Spreading Sequences, Wideband Direct-Sequence Systems, Cellular Networks and Power Control, Multiuser Detectors, Frequency-Hopping Multiple Access	6
VI	**Detection of Spread-Spectrum Signals** Detection of Direct-Sequence Signals, Ideal Detection, Radiometer, Detection of Frequency-Hopping Signals, Ideal Detection, Wideband Radiometer, Channelized Radiometer	7

Textbooks	
1	R. C. Dixen, “Spread Spectrum Systems with commercial application”, John Wiley, 3rd Edition
2	Andrew j. Viterbi, "CDMA : Principles of spread spectrum communication", Pearson Education, 1 st Edition, 1995
3	
4	
References	
1	George R. Cooper, Clare D. Mc Gillem, "Modern Communication and Spread Spectrum", McGraw Hill, 1986
2	Rodger E Ziemer, Roger L. Peterson and David E Borth, "Introduction to Spread Spectrum Communication", Pearson Education, 1st Edition, 1995.
3	
4	
Useful Links	
1	
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CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem.-I
Course Code	1EC516
Course Name	Navigation and Countermeasures
Desired Requisites:	Communication System

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	To understand the concept of Radar, its applications and different Radar performance
2	To understand the concept of Navigation and types of radio navigation
3	To Study the various Electronic Intercept System
4	To study the countermeasures and counter countermeasures.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Demonstrate the various types of radar and its operations.	III
CO2	Illustrate the various navigation techniques.	III
CO3	Construct the Electronic Intercept system for various applications.	V
CO4	Analyze the countermeasures and counter countermeasures communications	IV

Module	**Module Contents**	**Hours**
I	**Introduction to Radar** Radar concept block diagram operation , frequency ranges , applications, range equation derivation, Radar performance factors, minimum detectable signal, receiver noise, Signal to Noise ratio , Radar cross section of targets , transmitter power, pulse repetition frequency, range ambiguities	
II	**Types of Radar** Doppler effect, FM -CW Radar, FM -CW Radar with super heterodyne receiver block diagram MTI Radar: MTI Radar with power amplifier transmitter , delay line cancelers - MTI Signal Processor, Pulse Doppler Radar, Tracking Radar, basic block diagram types, Radar displays, A Scope, PPI Scope	
III	**Radio Navigation** Navigation, methods of navigation, Radio direction finder, loop antenna, Radio Navigation systems: ADF/NDB , Radio compass ADF, VHF phase comparison using ADF, Hyperbolic navigation systems, basic principle , LORAN, Omega, DECCA, Radio ranges, VOR, ground equipment, VOR receiver , Doppler VOR, DME	

IV	**Electronics Intercept System** Equation of Passive System, Radar warning Receiver, Electronics Support measures, Electronics Intelligent system, Advance Passive location technique, Infrared Intercept System, Communication ESM and Communication Intelligence	
V	**Electronic Countermeasure System** Operational Jamming Mode, On-board ECM System, ECM Technique, Infrared Countermeasures, Off Bard Countermeasures, Communication Countermeasures, Information Warfare	
VI	**Electronic Counter Countermeasures** Search Radar Counter countermeasures, Tracking Radar Counter countermeasures, Infrared Counter countermeasures, Communication Counter countermeasures **New Defence Technique and Technologies:** New Defence architecture, ED Basic Technologies advance, Shared Aperture, HPM Weapons, Anti Radiation Missile Technique, Anti Stealth technique	

Textbooks	
1	Radar Systems and Radio Aids to Navigation – Dr. A. K. Sen, Dr. A. B. Bhattacharya Khanna Publishers
2	Filippo Neri, *Introduction to Electronic Defense Systems, Third Edition* , Artech, 2018
3	
4	
References	
1	Radar Principles, Technology, Applications-ByronEdde, Pearson Education, 2004.
2	Elements of Electronic Navigation – N. S. Nagaraja – Tata McGraw H
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Useful Links	
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CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*					
AY 2024-25					
Course Information					
Programme	M. Tech. (Electronics and Communication Engineering)				
Class, Semester	First Year M. Tech., Sem.-II				
Course Code	1EC521				
Course Name	Antenna Design				
Desired Requisites:	Electromagnetic and basic Antenna				
Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives	
1	To study the antenna array and its elements
2	To understand the various broadband antenna and its applications
3	To identify the smart antenna for various application
4	To study the microstrip antenna configuration

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Categorize the antenna array based on the radiation pattern and bandwidth	IV
CO2	Design broadband and aperture antenna with given band of frequency.	V
CO3	Construct the microstrip antenna for specific applications	V
CO4	Analyse the smart antenna and MIMO antenna and its configuration for various applications.	IV

Module	**Module Contents**	**Hours**
I	**Arrays: Linear, Planar, and Circula** Two-Element Array, N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity, Design Procedure, N-Element Linear Array: Three-Dimensional Characteristics, Rectangular-to-Polar Graphical Solution, N-Element Linear Array: Uniform Spacing, Nonuniform Amplitude, Superdirectivity, Planar Array, Design Considerations, Circular Array	7
II	**Broadband Antennas** Broadband Dipoles**,** Traveling Wave Antenna, V Antenna, Rhombic Antenna, Helical Antenna, Electric-Magnetic Dipole, Yagi-Uda Array of Linear Elements, Yagi-Uda Array of Loops	7

III	**Aperture Antennas** Field Equivalence Principle: Huygens' Principle, Radiation Equations, Directivity, Rectangular Apertures, Circular Apertures, Design Considerations, Babinet's Principle, Ground Plane Edge Effects: The Geometrical Theory of Diffraction	6
IV	**Microstrip Antennas Design** Introduction, Characteristics of Microstrip Antennas, Feeding Techniques, Methods of Analysis, Review of Various Broadband Techniques for Microstrip Antennas, Broadband Compact Microstrip Antennas, Tunable and Dual-Band Microstrip Antennas, Broadband Circularly Polarized Microstrip Antennas, Broadband Planar Monopole Antennas	7
V	**Smart Antenna Configurations** Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas. Fixed Sidelobe Canceling, Retrodirective Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beamformers, Switched Beam Systems, Multiple Fixed Beam System. Uplink Processing, Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beamforming, Fixed Multiple Beams versus Adaptive Beamforming, Downlink Processing.	6
VI	**MIMO Antennas** Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO, SIMO, MISO,MIMO, Hybrid antenna array for mmWave massive MIMO: Massive Hybrid Array Architectures, Hardware Design for Analog Subarray	6

Textbooks	
1	Antenna Theory: Analysis and Design, 3rd Edition, C A Balanis, Wiley Publication
2	Kumar Girish, Broadband microstrip antennas, Artech House, ISBN 1-58053-244-6, 2003
3	
4	

References	
1	Antennas, J D Krauss, Mcgraw-Hill Higher Education
2	Milligan, Thomas A., Modern antenna design, 2005 by John Wiley & Sons. ISBN-13 978-0-471-45776-3
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Useful Links	
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CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem.-II
Course Code	1EC522
Course Name	Sensor Networks and Cloud Computing
Desired Requisites:	TCP-IP Protocols

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	- Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	To explain the Wireless Sensor Network and its applications
2	To understand WSN connectivity with Internet
3	To compare various MAC protocols for Wireless Sensor Network
4	To explain in a concise manner how the general Internet as well as Internet of Things work.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Identify applications and various challenges of Wireless Sensor Network	Apply
CO2	Categorize Wireless Sensor Network on different terminologies	Analyze
CO3	Compare various MAC and Routing protocols for Wireless Sensor Networks	Analyze
CO4	Apply Internet and Cloud concepts in IOT applications	Apply

Module	**Module Contents**	**Hours**
I	**Module 1 : Introduction of WSN** Overview of Wireless Sensor Networks, Applications and Challenges, Mobile ad hoc networks and wireless sensor networks, Hardware components, Energy consumption , Operating systems and execution environments	5
II	**Module 2: Wireless Sensor Network Architecture** Types of sources and sinks, Optimization Goals and Figures of Merit, Design principles for WSNs, Gateway Concepts, Need for gateway, WSN and Internet Communication, WSN Tunneling	6
III	**Module 3: WSN (Medium access control and Network layer)** Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts,Contention Based protocols, Schedule-based protocols - SMAC – BMAC, Traffic- adaptive medium access protocol (TRAMA), The IEEE 802.15.4 MAC protocol.Routing Protocols for WSN- different types.	7
IV	**Module 5: IoT** IoT definitions: overview, applications, potential & challenges, and architecture. M2M Protocols for Sensor Networks. IoT CASE Study.	6
V	**Module 6: Introduction to Cloud Computing** Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers Properties, Characteristics & Disadvantages, Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing.	7

VI	**Module 6: Cloud computing and Introduction to SDN** Cloud computing stack, Comparison with traditional computing architecture (client/ server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models, SDN: Introduce software-defined network: the background, the development, and the challenges.	7
Textbooks		
1	Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks Technology Protocols and Applications", John Wiley & Sons Inc. Publication ,2007	
2	"Internet of Things Applications and Protocols ", Wiely publication 2nd Ed.	
3	Peter Waher, "Learning Internet of Things",	
4	Anand Tamboli,"Build Your Own IoT Platform: Develop a Fully Flexible and Scalable Internet of Things Platform", January 2019	
References		
1	Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols" ,CRC Press, August 2003	
2	Akyildiz, Mehmet Can Vuran,"Wireless Sensor Networks" ,John Wiley & Sons Ltd. 2010	
3	William Stallings, "Foundations of Modern Networking : SDN, NFV, QoE, IoT and Cloud" Pearson Education	
4	By Miller Michael ,"Internet of Things, The: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World",Kindle Edition	
Useful Links		
1	https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs09/	
2	https://onlinecourses.nptel.ac.in/noc21_cs17/preview	
3	https://www.coursera.org	
4	http://www.atdc.iitkgp.ac.in/technologies-for-iot-ioe.html	

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		
CO3			3	3		2
CO4				2		2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC523
Course Name	Wireless and Mobile Communication
Desired Requisites:	Communication Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	# Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	# Hrs/week	30	20	50	100
		Credits: #			

Course Objectives

1	To study the wireless communication and cellular system.
2	To study the Mobile Radio Propagation
3	To study the Equalization and Diversity
4	To study the Wireless Networks

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Design the cell using frequency reuse technique.	V
CO2	Construct the propagation model for various applications	V
CO3	Examine the performance of the fading channels and access system.	IV
CO4	Formulate the wireless network system	VI

Module	**Module Contents**	**Hours**
I	**The Cellular Concept—System Design Fundamentals** Introduction to Wireless Communication Systems, Evolution of Mobile Radio Communications, Examples of Wireless Communication Systems, Trends in Cellular Radio and Personal Communications, The Cellular Concept—System Design Fundamental, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular Systems	6
II	**Mobile Radio Propagation: Large-Scale Path Loss**, Introduction to Radio Wave Propagation, Free Space Propagation Model, Three Basic Propagation Mechanisms, Reflection, Diffraction, Scattering, Practical Link Budget Design Using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings **Mobile Radio Propagation: Small-Scale Fading and Multipath** Small-Scale Multipath Propagation, Small-Scale Multipath Measurements, Parameters of Mobile Multipath Channels, Types of Small-Scale Fading, Rayleigh and Ricean Distributions, Theory of Multipath Shape Factors for Small-Scale Fading Wireless Channels	8

III	**Modulation Techniques for Mobile Radio** Digital Modulation—an Overview, Line Coding, Pulse Shaping Techniques, Geometric Representation of Modulation Signals, Linear Modulation Techniques, Constant Envelope Modulation, Combined Linear and Constant Envelope Modulation Techniques, Spread Spectrum Modulation Techniques, Modulation Performance in Fading and Multipath Channels	6
IV	**Equalization, Diversity, and Channel Coding** Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a Communications Receiver, Survey of Equalization Techniques, Linear Equalizers, Algorithms for Adaptive Equalization, Fractionally Spaced Equalizers, Diversity Techniques, RAKE Receiver, Interleaving, Fundamentals of Channel Coding, Block Codes and Finite Fields, Convolutional Codes	7
V	Multiple Access Techniques for Wireless Communications Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum Multiple Access, Space Division Multiple Access, Packet Radio, Capacity of Cellular Systems	6
VI	**Wireless Networking** Introduction to Wireless Networks, Differences Between Wireless and Fixed Telephone Networks, Development of Wireless Networks, Fixed Network Transmission Hierarchy, Traffic Routing in Wireless Networks, Wireless Data Services, Common Channel Signaling, Integrated Services Digital Network, Signaling System No. 7, Personal Communication Services/Network, Protocols for Network Access, Network Databases **Wireless Systems and Standards:** Global System for Mobile (GSM), CDMA Digital Cellular Standard (IS-95)	6

Textbooks	
1	Wireless Communications, Principles, Practice – Theodore, S. Rappaport, 2nd Ed., 2002, PHI
2	Mobile Cellular Communication – Gottapu Sasibhushana Rao, Pearson Education, 2012
3	
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References	
1	Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press.
2	Wireless Digital Communications – Kamilo Feher, 1999, PHI.
3	
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Useful Links	
1	
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CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						

CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information

Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC571
Course Name	Antenna Design Lab
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	0 Hrs/ Week	30	30	40	100
		Credits: 1			

Course Objectives

1	To study the antenna array and its elements
2	To understand the various broadband antenna and its applications
3	To identify the smart antenna for various application
4	To study the microstrip antenna configuration

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Categorize the antenna array based on the radiation pattern and bandwidth	IV
CO2	Design broadband and aperture antenna with given band of frequency.	V
CO3	Construct the microstrip antenna for specific applications	V
CO4	Analyse the smart antenna and MIMO antenna and its configuration for various applications.	IV

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

1 Design array to achieve optimum pattern
2 Design array of 5 elements to achieve optimum pattern
3 Design of Simple End Fire Array
4 Design of Equiangular Spiral Antenna
5 Design of Log Periodic Dipole
6 Design of Rhombic Antenna
7 Design of 3 element of Yagi Uda Antenna
8 Design of 6 element of Yagi Uda Antenna
9 Design of a 5 element Broad Side Array which has optimum pattern
10 Four Patch Array

Textbooks

1	Antenna Theory: Analysis and Design, 3rd Edition, C A Balanis, Wiley Publication
2	Kumar Girish, Broadband microstrip antennas, Artech House, ISBN 1-58053-244-6, 2003
3	
4	
References	
1	Antennas, J D Krauss, Mcgraw-Hill Higher Education
2	Milligan, Thomas A., Modern antenna design, 2005 by John Wiley & Sons. ISBN-13 978-0-471-45776-3
3	
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Useful Links	
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CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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AY 2024-25

Course Information

Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC572
Course Name	Sensor Networks and Cloud Computing Lab
Desired Requisites:	Embedded System, TCP/IP Protocol

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-Hrs/ Week	30	30	40	100
		Credits: 1			

Course Objectives

1	To determine suitable application of Wireless Sensor Network and IoT
2	To learn IoT sensors interfacing
3	To understand the Product Development Process through Mini Project.
4	To understand the importance of document design by compiling Technical Report on the Mini Project work carried out.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Identify Problem that can be solved using Wireless Sensor Network	Apply
CO2	Design and Develop system for selected problem	Apply
CO3	Examine designed system	Analyze
CO4	Determine the overall system performance with conclusion	Evaluate

List of Experiments / Lab Activities/Topics

List of Lab Activities:

1. The students should understand following aspects while planning Mini Project
   a. Concept of WSN and IoT
   b. Importance
   c. Interdisciplinary
   d. Challenges
   e. Various applications/smart objects
   f. Major Players/Industry, Standards.
2. In discussion with the concerned faculty during Laboratory hours Student should plan the Mini project/ application and prepare synopsis
3. The progress of work and discussion must be documented.
4. Testing of final product, Preparation, Checking & Correcting be done in discussion with faculty
5. The Student must submit a brief project report that should include the following
   a. Introduction
   b. Literature survey
   c. Hardware & Software Requirements
   d. System Design Architecture
   e. Implementation (screenshots to be included)
   f. Testing
   g. Conclusion
   h. Future enhancements.
   i. Bibliography

Textbooks	
1	Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks Technology Protocols and Applications", John Wiley & Sons Inc. Publication ,2007
2	"Internet of Things Applications and Protocols ", Wiely publication 2nd Ed.
3	Peter Waher, "Learning Internet of Things",
4	Anand Tamboli,"Build Your Own IoT Platform: Develop a Fully Flexible and Scalable Internet of Things Platform", January 2019
References	
1	Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols" ,CRC Press, August 2003
2	Akyildiz, Mehmet Can Vuran,"Wireless Sensor Networks" ,John Wiley & Sons Ltd. 2010
3	William Stallings, "Foundations of Modern Networking : SDN, NFV, QoE, IoT and Cloud" Pearson Education
4	By Miller Michael ,"Internet of Things, The: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World",Kindle Edition
Useful Links	
1	https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs09/
2	https://onlinecourses.nptel.ac.in/noc21_cs17/preview
3	https://www.coursera.org
4	http://www.atdc.iitkgp.ac.in/technologies-for-iot-ioe.html

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3					
CO2			2			
CO3					2	
CO4		3		3		2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli

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AY 2026-27

Course Information

Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC546
Course Name	Mini Project and Seminar
Desired Requisites:	---

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 2			

Course Objectives

1	To expose students to emerging technologies and current research trends in Electronics and Communication Engineering.
2	To develop skills in problem identification, literature review, technical analysis, and analytical, simulation, experimental, or hardware-based solutions to design.
3	To enhance technical communication, presentation, and report-writing abilities.
4	To teach how to judge the value of different contributions and identify promising new directions in specified area.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Identify** and **analyze** contemporary research problems in Electronics and Communication Engineering through comprehensive literature surveys.	Apply
CO2	**Design**, implement, and evaluate solutions for engineering problems through mini-project work using appropriate tools and techniques.	Create
CO3	Critically **analyze** and present technical literature and research findings through seminars and technical discussions.	Analyze
CO4	**Effectively communicate** technical ideas, project outcomes, and research insights through an effective seminar report and seminar presentations while adhering to professional ethics.	Evaluate

List of Experiments / Lab Activities/Topics

Contents:

The Mini Project and Seminar shall commence in Semester-II and should preferably address a problem of significant research relevance in the field of Electronics and Communication Engineering. The work shall involve the identification and formulation of a research problem, comprehensive review of scientific and technical literature, design and development of suitable methodologies, generation or collection of data, analysis and interpretation of results, and formulation of an effective solution. The mini project is expected to encourage originality, innovation, and independent thinking, while highlighting the individual contribution of the student.

The seminar shall preferably be based on the area in which the student intends to undertake the dissertation work. Students shall identify and investigate contemporary engineering challenges and emerging research domains through an extensive literature survey and critical review of research publications, journals, conference proceedings, patents, and technical reports. The study may focus on recent advances in areas such as advanced communication systems, Internet of Things (IoT), embedded systems, VLSI design, signal and image processing, artificial intelligence, machine learning, wireless communications, and other related technologies.

Each student shall undertake a Mini Project involving problem formulation, system design, modeling, simulation, implementation, testing, validation, and performance evaluation using appropriate engineering tools, techniques, and methodologies. The seminar presentation shall be based on the Mini Project undertaken and should demonstrate a clear understanding of the problem, methodology adopted, results obtained, and critical analysis of the findings. The presentation should also highlight the effectiveness and limitations of the proposed solution and indicate possible directions for future work. The course shall emphasize technical report writing, effective presentation skills, research ethics, plagiarism awareness, intellectual property rights, and professional communication practices. These activities are intended to prepare students for advanced research, innovation, and lifelong learning in the field of Electronics and Communication Engineering.

Students shall maintain regular interaction with their project guide, and the topic of the Mini Project and Seminar shall be selected through mutual consultation between the student and the guide. Evaluation shall be based on the quality of the work carried out, periodic progress, seminar presentation, and the final report. The report shall include the literature review, detailed problem statement, methodology, design and implementation aspects, experimental or simulation results, analysis and discussion, case studies (where applicable), conclusions, and references. The completed work shall be presented before a panel of examiners constituted by the Department Postgraduate Committee for assessment and evaluation.

Textbooks	
1	Suitable books based on the contents of the dissertation/seminar/mini project topic selected.
2	
References	
1	Suitable books based on the contents of the dissertation/seminar/mini project topic selected and research papers from reputed national and international journals and conferences.
2	
Useful Links	
1	https://ieeexplore.ieee.org
2	https://www.sciencedirect.com
3	https://www.elsevier.com

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3	3	2	2		2
CO2	3	3	3	3		3
CO3	2	3	3	3	2	2
CO4		3	3		3	
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty	During Week 13 Marks Submission at the end of Week 13	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC531
Course Name	Embedded Linux System Design
Desired Requisites:	Embedded Linux programming

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To facilitate students to learn the web technology on embedded Linux platform.
2	To help the students to design static and dynamic website for solving social problems using embedded Linux and web framework.
3	To help the students to develop embedded Linux based system
4	To understand different applications of Embedded Linux System Design

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Design** a website using a frontend, backend languages/ scripts and framework.	Understand
CO2	**Connect** embedded system with front end / back end using Embedded Linux	Apply
CO3	**Design** and **develop** web based solution for social problems using the Embedded Linux.	Create
CO4	**Implement** solution for social problems using the Embedded Linux.	Create

Module	**Module Contents**	**Hours**
I	**Introduction to web technology** Fundamentals of Web technology, Web server, Web Client, Server and client side scripting. Installation of Web server on EL boards and accessing them over intranet.	5
II	**Web Programming** Frontend design, using HTML and CSS, Backend design using PHP, Python, SQL; Using web server for static / dynamic content, Responsive site basics and design.	7
III	**Web Design Framework** PHP Frameworks Code igniter / Python Frameworks Flask, Basics of database and updating database directly from Embedded Linux based system, dynamic webpage for web based system.	7
IV	**System Configuration** Configure Network Setup & Remote access, Controlling GPIOs, Installing required packages / libraries, Interfacing various peripherals, Sensors, Camera etc. to Embedded Linux Board, accessing / handling hardware using Python.	7

V	**System Design** Design steps to implement system using Embedded Linux platform, Web based system design for real world problem, Introduction to device driver, architecture, types of it and programming example.	7
VI	**Applications** Case study on embedded Linux system design for web based Applications, IoT Applications, Image Processing based Applications.	6
Textbooks		
1	Robin Nixon, Learning PHP, MySQL & JavaScript, O'Reilly publication, 4th Edition, 2015,ISBN: 9789352130153	
2	Kogent Learning Solutions Inc, Web Technologies: HTML, JAVASCRIPT, PHP, Dreamtech Press(2009) ISBN: 978-8177229974	
3	Carlos de la Guardia , "Python Web Framework", O'Reilly Media, Inc.	
4	Gareth Halfacree, "THE OFFICIAL Raspberry Pi Beginner's Guide - How to use your new computer" , 4th Edition, Raspberry Pi press.	
References		
1	Frank Vasquez, Chris Simmonds, "Mastering Embedded Linux Programming: Create fast and reliable embedded solutions with Linux 5.4 and the Yocto Project 3.1", 3rd edition, Packt Publishing.	
2	"Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux", 1st edition, Wiley.	
3	Fabrizio Romano, Gaston C. Hillar, Arun Ravindran "Learn Web Development with Python: Get hands-on with Python Programming and Django web development", Packt Publishing Limited.	
4	John C. Shovic ,"Raspberry Pi IoT Projects: Prototyping Experiments for Makers", March 2021 Apress.	
Useful Links		
1	https://jaycarlson.net/embedded-linux/	
2	https://www.tutorialspoint.com/unix/index.htm	
3	https://www.raspberrypi.com/	
4	https://www.raspberrypi.org/	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3	3		
CO2			3	3		
CO3				2		2
CO4						2
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC532
Course Name	RTL Simulation and Synthesis
Desired Requisites:	Digital Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	To develop the concept of digital design.
2	To explain simulation of digital system using FSM.
3	To explain the design of the processor using data path.
4	To explain the ASIC flow, IP.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Design** finite state machines and perform timing analysis.	Design
CO2	**Model**, simulate, verify the synchronous digital design with Verilog HDL.	Analyse
CO3	**Understand** the concept of CPLD, FPGA, SoC and IP.	Understand
CO4	**Design**, **Analyse** and **Verify** the synchronous digital design on FPGAs.	Analyse

Module	**Module Contents**	**Hours**
I	Top down approach, Hardware modelling of combinational and sequential circuits with Verilog HDL, writing a test bench	6
II	Design of finite state machines (Synchronous and asynchronous), system design using ASM chart, Static Timing analysis, Meta-stability, clock issues, Need and design strategies for Multi-Clock Domain designs.	6
III	Data path and Control path design, Arithmetic implementation strategies for data path design, Processor Design, Micro-programmed control design, Single cycle MMIPS	8
IV	Processor Design, Micro-programmed control design, Single cycle MMIPS	6
V	ASIC Design flow- Introduction to ASIC Design Flow, SOC, Floor planning, Placement, Clock tree synthesis, Routing, Physical verification, Power analysis, Design for performance, Low power VLSI design techniques, Technology Challenges	8
VI	IP and Prototyping.	6

Textbooks

1	Stephen Brown and ZvonkoVranesic, "Fundamentals of Digital logic with Verilog Design", 3rd edition, Mc-GrawHill.
2	John P. Hayes McGraw-Hill, "Digital VLSI Design with Verilog HDL", 3rd edition, 1998.
3	
4	

References	
1	Donald D Givone, “Digital principles and Design”, Tata Mc-Graw Hill, 2003
2	Ben Cohen, “Real Chip design and Verification using Verilog and VHDL”, Vhdl Cohen Publishing, 2002
3	Doug Amos, Austin Lesea, Rene Richter, “FPGA based prototyping methodology manual”, Xilinx
4	
Useful Links	
1	
2	
3	
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2					2
CO2	1		2			2
CO3			1			1
CO4	1			2		2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC533
Course Name	Advanced Optical Communication
Desired Requisites:	Optical Communication

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives	
1	To study the light wave systems necessary for optical communication
2	To understand the signal processing optical communication
3	To learn the optical amplifier concepts for light transmission through fiber.
4	To study the multichannel system and its components

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Design the optical fiber amplifier for communication.	V
CO2	Compare the multichannel system requirement for various applications.	VI
CO3	Analyze the fiber losses and its effect on system	IV
CO4	Apply various stwitching technique for optical signal processing.	III

Module	**Module Contents**	**Hours**
I	**Optical Fiber Amplifiers,** Basic Concepts, Semiconductor Optical Amplifiers, Raman Amplifiers, Erbium-Doped Fiber Amplifiers, System Applications	7
II	**Multichannel Systems** WDM Lightwave Systems, WDM Components, System Performance Issues, Time-Division Multiplexing, Subcarrier Multiplexing, Code-Division Multiplexing	7
III	**Lightwave Systems** System Architectures, Design Guidelines, Long-Haul Systems, Sources of Power Penalty, Forward Error Correction,	6
IV	**Advanced Lightwave Systems** Advanced Modulation Formats, Demodulation Schemes, Shot Noise and Bit-Error Rate, ensitivity Degradation Mechanism, Impact of Nonlinear Effects, Systems with the DBPSK, DQPSK and QAM format	6
V	**Optical Signal Processing** Nonlinear Techniques and Devices, All-Optical Flip-Flops, Wavelength Converters, Ultrafast Optical Switching, Optical Regenerators	6
VI	**Loss Management,** Compensation of Fiber Losses, Erbium-Doped Fiber Amplifiers , Raman Amplifiers , Optical Signal-To-Noise Ratio, Electrical Signal-To-Noise Ratio, Receiver Sensitivity and Q Factor, Role of Dispersive and Nonlinear Effects ,	7

Textbooks

1	Optical Fiber Communications: Principles and Practice (3rd Edition), John Senior, Prentice Hall (2008).
2	Fiber-Optic Communication Systems, Govind P. Agrawal, Wiley-Interscience; 3rd Ed. (2002)
3	
4	
References	
1	Gerd Keiser, Optical Fiber Communication, 4th Edition, Tata McGraw-Hill Ltd., 2008 (Indian Edition).
2	A. Ghatak, K. Thyagarajan, Introduction To Fiber Optics, Foundation Books, 2002 (Indian Edition).
3	
4	
Useful Links	
1	
2	
3	
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	1EC534
Course Name	Biomedical Signal Processing
Desired Requisites:	Signals and Systems, Digital Signal Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To study origins and characteristics of biomedical signals including ECG, EEG, evoked potentials, and EMG
2	To explore application of established engineering methods to complex biomedical signals problems
3	To analyze the various signal processing techniques used for biomedical signals.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Understand different types of Biomedical signals and characteristics	Understand
CO2	Apply signal processing techniques to biomedical signals	Apply
CO3	Analyze ECG and EEG signal with	Analyze
CO4	Model a biomedical system	Create

Module	**Module Contents**	**Hours**
I	**Introduction to Biomedical Signals** Introduction to Biomedical Signals, the nature of Biomedical Signals, Examples of Biomedical Signals, Action Potential of a Cardiac myocyte, Action Potential of a neuron, Electroneurogram (ENG), Electromyogram (EMG), Electrocardiogram (ECG), Electroencephalogram (EEG), The speech signal, Objectives of Biomedical Signal processing, difficulties in Biomedical analysis, why use computer-aided diagnosis (CAD)?	6
II	**Signal Averaging and Data Compression Techniques** Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding.	6
III	**Adaptive Noise Cancellation Adaptive interference / Noise cancellation** Types of noise in bio-signals; Digital filters - IIR and FIR - Notch filters - Optimal and adaptive filters. Weiner filters - steepest descent algorithm - LMS adaptive algorithm - Adaptive noise canceller - cancellation of 50 Hz signal in ECG - Cancellation of maternal ECG in foetal electrocardiography	7

IV	**Cardiological signal processing** Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Realtime ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor.	7
V	**Neurological signal processing** Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. Analysis of EEG channels: Detection of EEG rhythms, Template matching for EEG, spike and wave detection	6
VI	**Modeling of Biomedical Systems** Motor unit firing pattern, Cardiac rhythm, Formants, and pitch of speech, Point process, Parametric system modeling, Autoregressive model, Autocorrelation method, Application to random signals, Computation of model parameters, Levinson-Durbin algorithm, Computation of gain factor, Covariance method, Spectral matching and parameterization, Model order selection, Relation between AR and Cepstral coefficients	8

Textbooks	
1	R M Rangayyan "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002
2	E.N. Bruce, Biomedical Signal Processing and Signal Modelling, John Wiley and Sons, 2001
3	W. J. Tompkins, ed., Biomedical Signal Processing; Prentice Hall, 1995
4	D. C. Reddy, Biomedical Signal Processing – Principles and Technique, Tata McGraw-Hill.,2005

References	
1	Akay M. "Biomedical Signal Processing", Academic press, California,1994.
2	Bronzino J D "The Biomedical Engineering handbook", CRC and Free press, Florida, 1995.

Useful Links	
1	NPTEL LECTURES: https://onlinecourses.nptel.ac.in/noc20_ee41/preview

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3					
CO2			2			
CO3				2		
CO4						1
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1EC535
Course Name	Automotive Electronics
Desired Requisites:	-

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: #			

Course Objectives

1	To learn the basic control system and sensor required Engine control
2	To learn basic of signal conversion circuit in Automotive system
3	To enhance skill of communication in automotive vehicle
4	To explore advances in Automotive industry

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Understand the importance of fuel economy and government rules in automotive industry	Understand
CO2	Use various sensor system to control engine and its devices	Understand
CO3	Apply knowledge of communication to device for controlling devices	Apply
CO4	Analyse a problem and identify the computing requirements for engine control instrumentation	Analyze

Module	**Module Contents**	**Hours**
I	**Module 1: The Basics of Electronic Engine Control** Motivation for Electronic Engine Control. Exhaust Emissions, Fuel Economy, Federal Government Test Procedures, Concept of an Electronic Engine Control System, Definition of Engine Performance Terms, Exhaust Catalytic Converters, Electronic Fuel Control System, Analysis of Intake Manifold Pressure, Idle Speed Control, Electronic Ignition	6
II	**Module 2: Sensors and Actuators** Automotive Control System Applications of Sensors and Actuators, Throttle Angle Sensor, Temperature Sensors, Typical Coolant Sensor, Sensors for Feedback Control, Knock Sensors, Angular Rate Sensor, LIDAR, Digital Video Camera, Flex-Fuel Sensor, Automotive Engine Control Actuators, Variable Valve Timing, Electric Motor Actuators, Stepper Motors, Ignition System	7
III	**Module 3: Digital Powertrain Control Systems** Digital Engine Control, Control Modes for Fuel Control, Discrete Time Idle Speed Control, EGR Control, Variable Valve Timing Control, Turbocharging, Direct Fuel Injection, Flex Fuel, Electronic Ignition Control, Integrated Engine Control System, Summary of Control Modes	7
IV	**Module 4: Vehicle Motion Controls** Representative Cruise Control System, Cruise Control Electronics, Antilock Braking System, Electronic Suspension System, Electronic Suspension Control System, Four-Wheel Steering CAR	7

V	**Module 5: Automotive Instrumentation** Modern Automotive Instrumentation, Input and Output Signal Conversion, Display Devices, Fuel Quantity Measurement, Coolant Temperature Measurement, Oil Pressure Measurement, Vehicle Speed Measurement,	6
VI	**Module 6: Vehicle Communications** IVN, CAN, Local Interconnect Network (LIN), FlexRay IVN, MOST IVN, Vehicle to Infrastructure Communication, Vehicle-to-Cellular Infrastructure, Short-Range Wireless Communications, Satellite Vehicle Communication, GPS Navigation, Safety Aspects of Vehicle-to-Infrastructure Communication	6
Textbooks		
1	*Understanding Automotive Electronics An Engineering Perspective by* William Ribbens,Elsevier	
2	Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, Robert Bosch GmbH, Springer Science & Business Media, 2013	
References		
1	Automotive Electronics Design Fundamentals, Najamuz Zaman, Springer Cham, October 2016	
2	Automotive Electronics Handbook, Ronald K. Jurgen, McGraw Hill Professional, 1999	
Useful Links		
1	https://en.wikipedia.org/	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1					
CO2			2			
CO3	2					
CO4				2		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem.-II
Course Code	1EC536
Course Name	DSP in VLSI
Desired Requisites:	-

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To ***introduce*** the fundamentals of VLSI signal processing and expose them to examples of applications.
2	To ***understand*** the basic parameters like critical period, loop bound, iteration bound etc. from architecture point of view to design high speed digital systems for DSP applications.
3	To ***explain*** various approaches like pipelining, parallel processing, retiming, unfolding, folding etc. to optimize above performance parameters for high speed digital systems without ignoring area and power minimization.
4	***Design*** and optimize VLSI architectures for basic DSP algorithms.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Define** and **describe** critical period, loop bound, iteration bound etc.	Understand
CO2	**Apply** various approaches like pipelining, parallel processing, Retiming, Unfolding, Folding, Systolic Array etc. for designing high speed and high throughput, energy efficient digital systems.	Apply
CO3	**Implement** above algorithms for few cases and compare merits and demerits of each algorithm.	Apply
CO4	**Design** a digital system for any high frequency applications taking into consideration any of the above algorithms.	Create

Module	**Module Contents**	**Hours**
I	**DFG Representation and Iteration Bound**: Representations of DSP algorithms Critical Period, Loop bound, Iteration bound, LPM and MCM algorithms.	7
II	**Pipelining and Parallel Processing:** Pipelining approach to reduce critical path Parallel Processing to handle higher sample rates, Power Reduction computations, Combined pipelining and Parallel processing.	7
III	**Retiming:** Introduction to Retiming (Definitions and properties), Solving system of inequalities, Cutset Retiming and Pipelining, Retiming for clock period minimization, Retiming for register minimization.	7
IV	**Unfolding:** Introduction to Unfolding, Algorithm for unfolding, Properties of unfolding, Sample Period Reduction, Word level and bit-level parallel Processing.	7

V	**Folding:** Introduction to folding, Folding Transformation, Lifetime Analysis for Register minimization in folded architecture, Folding of multi-rate DSP systems	6
VI	**Systolic Array Design:** Methodologies, Family of systolic arrays (FIR filter) using linear mapping techniques, Matrix – Matrix Multiplication.	5
Textbooks		
1	Keshab K. Parhi, "VLSI Digital Signal Processing Systems-Design and Implementation" , Wiley (India), 2007	
2		
3		
4		
References		
1	Mahesh Mehendale, Sunil Sherlekar, "VLSI Synthesis of DSP kernels- Algorithms and Architectural Transformations", Kluwer Publications, 2002	
2		
3		
4		
Useful Links		
1		
2		
3		
4		

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			1			
CO2	2			2		2
CO3	2			2		2
CO4	2			2		3
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1EC537
Course Name	Pattern Recognition and Image Analysis
Desired Requisites:	Image Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: #			

Course Objectives	
1	To understand the fundamental concepts and principles of pattern recognition.
2	To Learn about different classification algorithms and their applications in pattern recognition.
3	To Explore advanced topics in pattern recognition, such as deep learning and neural networks.
4	To explore the concepts of statistical pattern recognition and its applications.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	To **Identify** the key components and processes involved in pattern recognition systems.	Understand
CO2	To **Learn** the basics of Image processing and related algorithms in pattern recognition.	Understand
CO3	**Apply** feature extraction and selection methods to effectively represent and describe patterns in datasets.	Apply
CO4	**Analyze** and **interpret** the results of pattern recognition algorithms and models.	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction to Pattern Recognition:** Image Fundamentals required for Pattern Recognition, Definition and scope of pattern recognition, Components of Pattern Recognition Systems, Overview of the pattern recognition process, Evaluation metrics for pattern recognition systems, Applications of pattern recognition in various fields.	7
II	**Feature Extraction and Selection:** Feature representation and feature vectors, Feature extraction techniques (e.g., statistical, frequency domain, transform-based), Dimensionality reduction techniques (e.g., Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA)), Feature selection methods (e.g., Sequential Forward Selection (SFS), Genetic Algorithms).	7
III	**Bayesian Decision Theory:** Introduction to Bayes' theorem, Bayes decision rule and decision boundaries Minimum error rate classification, Classifiers based on Gaussian distributions (e.g., Naive Bayes, Gaussian Mixture Models).	6

IV	**Supervised Learning Algorithms:** Linear classifiers (e.g., Perceptron, Support Vector Machines (SVM)), k-Nearest Neighbors (k-NN) algorithm, Decision tree classifiers. **Unsupervised Learning and Clustering** Clustering algorithms (e.g., k-means, hierarchical clustering), Self-Organizing Maps (SOM).	7
V	**Neural Networks for Pattern Recognition:** Introduction to artificial neural networks (ANNs), Perceptrons and multilayer perceptrons (MLPs), Backpropagation algorithm for training ANNs, Convolutional Neural Networks (CNNs) for image recognition, Recurrent Neural Networks (RNNs) for sequence data.	6
VI	**Statistical Pattern Recognition:** Maximum Likelihood Estimation (MLE) and Maximum a Posteriori (MAP) estimation, Hidden Markov Models (HMMs) for sequential data, Gaussian Mixture Models (GMMs), Expectation-Maximization (EM) algorithm.	6

Textbooks	
1	Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision"
2	Christopher M. Bishop, "Pattern Recognition and Machine Learning",2006
3	Sergios Theodoridis and Konstantinos Koutroumbas, "Introduction to Pattern Recognition: A MATLAB Approach"
4	Richard O. Duda, Peter E. Hart, and David G. Stork ,"Pattern Classification"

References	
1	R. Schalkoff, Pattern Recognition - Statistiucal, Structural and Neural Approaches, John Wiley, 1992.
2	J.I. Tou & R.C. Gonzalez, Pattern Recognition Priciples, Addition-Wesley.

Useful Links	
1	https://www.coursera.org/learn/pattern-recognition-machine-learning
2	https://www.springer.com/gp/book/9780387310732
3	https://www.journals.elsevier.com/pattern-recognition
4	https://github.com/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1					
CO2			2			
CO3	2					
CO4				2		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	FY M. Tech., Sem. II
Course Code	1EC538
Course Name	Software Defined Radio
Desired Requisites:	Digital Communication

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	To study the communication probabilities and fundamentals for communication
2	To understand the SDR and its architecture with its applications.
3	To study the Timing, Carrier and Frame synchronization
4	To understand the channel synchronisation and equalization

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Interpret the detail about Software Defined Radio Architecture for performance optimization	III
CO2	Outline the complete knowledge regarding functioning of different blocks associated with Software Defined Radio.	IV
CO3	Demonstrate the timing, frequency, and frame synchronization,	III
CO4	Identify appropriate digital signals for RF signal processing/ implementation	IV

Module	**Module Contents**	**Hours**
I	**Introduction to Software-Defined Radio** Brief History, What is a Software-Defined Radio?, Networking and SDR, RF architectures for SDR, Processing architectures for SDR, Software Environments for SDR, Signal Representation, Signal Metrics and Visualization, Receive Techniques for SDR, Digital Signal Processing Techniques for SDR, Transmit Techniques for SDR	7
II	**Probability in Communications** Modeling Discrete Random Events in Communication Systems, Binary Communication Channels and Conditional Probability, Modeling Continuous Random Events in Communication Systems, Time-Varying Randomness in Communication Systems, Gaussian Noise Channels, Power Spectral Densities and LTI Systems, Narrowband Noise, Application of Random Variables: Indoor Channel Model, Digital Communications Fundamentals What Is Digital Transmission?, Digital Modulation, Probability of Bit Error, Signal Space Concept, Gram-Schmidt Orthogonalization, Optimal Detection, Basic Receiver Realizations,	8
III	**Understanding SDR Hardware** Components of a Communication System, Strategies For Development in MATLAB, Example: Loopback with Real Data, Noise Figure	5

IV	**Timing Synchronization** Matched Filtering, Timing Error, Symbol Timing Compensation, Alternative Error Detectors and System Requirements, Putting the Pieces Together,	6
V	**Carrier Synchronization** Carrier Offsets, Frequency Offset Compensation, Phase Ambiguity Frame Synchronization and Channel Coding Frame Synchronization, Putting the Pieces Together, Channel Coding	7
VI	**Channel Estimation and Equalization** Channel Estimation. Equalizers, Receiver Realization, Orthogonal Frequency Division Multiplexing Rationale for MCM: Dispersive Channel Environments, General OFDM Model, Common OFDM Waveform Structure, Packet Detection, CFO Estimation, Symbol Timing Estimation, Equalization, Bit and Power Allocation, Applications for Software-Defined Radio: Cognitive Radio, Vehicular Networking	6

Textbooks	
1	Travis F. Collins, Robin Getz, Di Pu, Alexander M. Wyglinski, **Software-Defined Radio for Engineers,** Artech House, ISBN-13: 978-1-63081-457-1,
2	Walter H. W. Tuttlebee , Software Defined Radio: Baseband Technologies for 3G Handsets and Basestations. 2004 John Wiley & Sons, Ltd. ISBN: 0-470-86770-1
3	Markus Dillinger, K.Madani and N. Alonistioti, Soft Defined Radio, 1st Ed., Wiley
4	

References	
1	By Andrew Barron , Software Defined Radio For Amateur Radio Operators And Shortwave Listeners,
2	L.H. Crockett, D. Northcote, R. W. Stewart (Editors), *Software Defined Radio with Zynq UltraScale+ RFSoC*, First Edition, Strathclyde Academic Media, 2023. https;//www.RFSoCbook.com.
3	Jeffrey H.Reed, "Software Radio: A Modern Approach to Radio Engineering" Reprint by Pearson Education & Inc 2002
4	Joseph Mitola, III, Software Radio Architecture: Object Oriented Approaches to Wireless Systems Engineering, John Wiley and Sons, 2000

Useful Links	
1	
2	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1						
CO2						
CO3						
CO4						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. (Electronics and Communication Engineering)
Class, Semester	First Year M. Tech., Sem. II
Course Code	7OE508
Course Name	Open Elective : Introduction to Embedded Systems
Desired Requisites:	Computer Programming, Digital Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To introduce Embedded Systems and Programming.
2	To develop understanding about Microcontrollers
3	To introduce hardware components of Embedded Systems
4	To explain fundamentals of Arduino To explore Arduino based applications and programming

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Understand** Embedded Systems and Identify their applications	Understand
CO2	**Develop** knowledge about hardware and software of Embedded Systems	Apply
CO3	**Analyze** Arduino based systems and their programming	Analyze
CO4	**Develop** Arduino based systems applications	Create

Module	**Module Contents**	**Hours**
I	**Introduction to Embedded System** Embedded Systems and general purpose computer systems, history, classifications, applications and purpose of embedded systems Characteristics and Applications of embedded systems: operational and non-operational quality attributes. Embedded Systems Applications-Application specific – washing machine, domain specific - automotive	5
II	**Core of embedded systems** Microprocessors and microcontrollers, RISC and CISC controllers, Big endian and Little endian processors, Application specific ICs, Programmable logic devices, COTS, sensors and actuators, communication interface, embedded firmware, other system components.	7
III	**Embedded Hardware** Memory map, i/o map, interrupt map, processor family, external peripherals, memory – RAM, ROM, types of RAM and ROM, memory testing, CRC, Flash memory. Peripherals**:** Control and Status Registers, Device Driver, Timer Driver - Watchdog Timers	7

IV	**Introduction to Arduino** Arduino device, Features of Arduino, Components of Arduino board, Description of Microcontrollers, Installation of Arduino IDE on Ubuntu Linux OS Run the Arduino executable file, Using IDE to prepare Arduino sketch, Uploading and running the sketch, Program notation: variables, functions, control flow, Arduino conventions. The concept of a program variable. Numerical values and basic numerical operators. if/then/else Iteration using for loops. Real world timing and the delay function	8
V	**Interfaces and Programming** Sensor Inputs: - Definition, Types. Interfacing Arduino to different sensors- light sensor, temperature sensor, humidity sensor, pressure sensor sound sensor, distance ranging sensor, water/detector sensor, smoke, gas, alcohol sensor, ultrasonic range finder, Displays: Basics of LED's and LCD's. Interfacing Arduino to LED's- blinking single LED, blinking multiple LED's, 7 segment display, traffic light, LED flashes, LED dot matrix, pulsating lamp. Interfacing to LCD's- Basic LCD control, LCD temperature control, display a message on LCD screen, scrolling of text Touch screens, Reading and writing to SD card	9
VI	**Arduino Applications** Case studies: Arduino based robot car, Arduino based PLC, industrial application	4
Textbooks		
1	Shibu K V , "Introduction to embedded systems", Tata McGraw-Hill, 1st edition	
2	Brian Jepson, Michael Margolis, Nicholas Robert Weldin , "Arduino Cookbook", O'Reilly Media	
3	Ashford Lee Edward, "Introduction to Embedded Systems", 2nd Ed. Paperback – 1 January 2019	
4		
References		
1	Raj Kamal, "Embedded Systems: Architecture, Programming and Design" Tata McGraw-Hill	
2	Michal Mc Roberts "Beginning Arduino" Second Edition, Technology in Action	
3	Steve furber, "ARM System-on-Chip Architecture", Pearson Education	
4	Frank Vahid and Tony Givargis, "Embedded System Design", Wiley	
Useful Links		
1	https://nptel.ac.in/courses	
2	https://www.coursera.org/	
3	https://www.tutorialspoint.com/	
4	https://www.arduino.cc/en/Tutorial/HomePage	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2	2		
CO2			2	2		
CO3				2		2
CO4						1
Low, 2: Medium, 3: High						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)