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Revised (*April 2026*)

M. Tech. Syllabus

[Communication Engineering]

Electronics and Communication Engineering,

North-Eastern Hill University,

Shillong - 793 022

Meghalaya

Table of Contents

1. Syllabus Scheme

1.1 Coding Used in the Syllabus

CC	-	Core Course
EC	-	Electronics and Communication Engineering
DSEC	-	Discipline Specific Elective Course
GEC	-	General Elective Course
RM	-	Research Methodology
SEC	-	Skill Enhancement Course

1.1.1 Course Coding for *Core Courses:*

Nomenclature used in the Course Code (e.g. EC-CC-XYZ):

XYZ

YZ → Course Serial Number

X → 4 + 1 for First Year/2 for Second Year :: 5 for First Year/6 for Second Year

1.1.2 Course Coding for *Elective Courses*:

Six Digit Numeric Numbers Used in Course Code (e.g. EC-GEC-XYZA)

XYZA

A → Elective Course Serial Number (It may have double digit as well)

YZ → Course Serial Number

X → 5 for First Year/6 for Second Year

1.2 Semester: I

Branch: *Electronics and Communication Engineering* **Year:** I **Semester:** I

Sl. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Papers			**L**	**T**	**P**	**TA**	**CT**	**ST**	**ESE**	**TOT**	
1	EC-CC-500	Advanced Signal Processing	3	1	0	20	20	40	60	100	4
2	EC-CC-501	Machine Learning	3	1	0	20	20	40	60	100	4
3	EC-DSEC-502xx	Discipline Specific Elective Course: Elective - I	3	1	0	20	20	40	60	100	4
4	EC-DSEC-503xx	Discipline Specific Elective Course: Elective - II	3	1	0	20	20	40	60	100	4
5	EC-GEC-504xx	Generic Elective Course (Multidisciplinary)	3	1	0	20	20	40	60	100	4
		Total	**15**	**5**	**0**	100	100	**200**	**300**	**500**	20

* Credit of this paper shall not be counted.

L - Lecture **T -** Tutorial **P -** Practical **TA -** Assesment by Teacher
CT - Class Test **ST -** Sub-Total **ESE -** End Semester Evaluation **TOT -** Total

Contact Hours: *20* **Total Marks:** *500* **Total Credits:** *20*

DSEC: Elective - I

1. EC-DSEC-50201 Wireless Communication
2. EC-DSEC-50202 Microwave Theory and Techniques
3. EC-DSEC-50203 Silicon Photonics

   Students are encouraged to select any one of the following 3- or 4-credit elective courses. Alternatively, they may opt for any available 3- or 4-credit relevant elective course offered online through the SWAYAM platform.(Course Code: EC-DSEC-50204).
4. Spread Spectrum Communications and Jamming
5. Fundamentals of Nano and Quantum Photonics
6. Stochastic Modeling and the Theory of Queues
7. Introduction to Embedded System Design
8. Circuit Analysis for Analog Designers

DESC: Elective - II

1. EC-DSEC-50301 Digital IC Design
2. EC-DSEC-50302 ARM Processor and Applications

   Students are encouraged to select any one of the following 3- or 4-credit elective courses. Alternatively, they may opt for any available 3- or 4-credit elective relevant course offered online through the SWAYAM platform.(Course Code: EC-DSEC-50303).
3. Computer Vision and Image Processing - Fundamentals and Applications
4. Discrete Structures
5. Communication Networks
6. Industrial Automation and Control
7. Fiber Optic Communication Technology

GEC: Generic Elective Course (Multidisciplinary)

1. EC-GEC-50401 Biosensors and Applications
2. EC-GEC-50402 Microfabrication and MEMS Sensors for Clinical Applications
3. EC-GEC-50403 Biomedical Instrumentation

1.3 Semester: II

Branch: *Electronics and Communication Engineering* **Year:** I **Semester:** II

Sl. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Papers			**L**	**T**	**P**	**TA**	**CT**	**ST**	**ESE**	**TOT**	
1	EC-CC-505	Advanced Wireless and Digital Communication	3	1	0	20	20	40	60	100	4
2	EC-CC-506	Advanced System Design Laboratory	0	0	4	0	20	20	30	50	2
3	EC-DSEC-507xx	Discipline Specific Elective Course (Practical): Elective - III	0	0	4	0	20	20	30	50	2
4	EC-DSEC-508xx	Discipline Specific Elective Course Elective - IV	3	1	0	20	20	40	60	100	4
5	EC-RM-509	Research Methodology and Proposal Writing	3	1	0	20	20	40	60	100	4
6	EC-SEC-510xx	Skill Enhancement Course (SEC)	3	1	0	20	20	40	60	100	4
		Total	**12**	**4**	**8**	80	120	**200**	**300**	**500**	20

* Credit of this paper shall not be counted.

L - Lecture **T -** Tutorial **P -** Practical **TA -** Assesment by Teacher
CT - Class Test **ST -** Sub-Total **ESE -** End Semester Evaluation **TOT -** Total

Contact Hours: *24* **Total Marks:** *500* **Total Credits:** *20*

DSEC: Elective - III (Practical)

1. EC-DSEC-50701 Advanced Communication Practices
2. EC-DSEC-50702 Advanced Practices in VLSI Devices and RF Circuits
3. EC-DSEC-50703 PIC Design Laboratory

DSEC: Elective - IV

1. EC-DSEC-50801 Antenna Analysis and Design
2. EC-DSEC-50802 VLSI Devices and Modeling
3. EC-DSEC-50803 Modern Digital Control System

   Students are encouraged to select any one of the following 3- or 4-credit elective courses. Alternatively, they may opt for any available 3- or 4-credit relevant elective course offered online through the SWAYAM platform.(Course Code: EC-DSEC-50804).

4. Biomedical Signal Processing
5. Engineering Statistics
6. RF and Microwave Networks
7. Photonic Integrated Circuit

SEC: Skill Enhancement Course (SEC)

1. EC-SEC-51001 Advanced Data Visualization and Analytics
2. EC-SEC-51002 Embedded System Design with Advanced Processors
3. EC-SEC-51003 Project Management for Managers
4. EC-SEC-51004 PIC Design

1.4 Semester: III

Branch: *Electronics and Communication Engineering* **Year:** II **Semester:** III

Sl. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Papers			**L**	**T**	**P**	**TA**	**CT**	**ST**	**ESE**	**TOT**	
3	EC-CC-600	Dissertation-I	0	0	16	40	40	80	120	200	8
4	EC-DSEC-601xx	Discipline-Specific Elective Course: Elective-V	3	1	0	20	20	40	60	100	4
5	EC-DSEC-602xx	Discipline-Specific Elective Course: Elective-VI	3	1	0	20	20	40	60	100	4
6	EC-DSEC-603xx	Discipline-Specific Elective Course: Elective-VII	3	1	0	20	20	40	60	100	4
		Total	**9**	**3**	**16**	100	100	**200**	**300**	**500**	20

* Credit of this paper shall not be counted.

L - Lecture **T -** Tutorial **P -** Practical **TA -** Assesment by Teacher
CT - Class Test **ST -** Sub-Total **ESE -** End Semester Evaluation **TOT -** Total

Contact Hours: *28* **Total Marks:** *500* **Total Credits:** *20*

DSEC: Elective -V

1. EC-DSEC-60101 Analog IC Design
2. EC-DSEC-60102 Speech Processing

   Students are encouraged to select any one of the following 3- or 4-credit elective courses. Alternatively, they may opt for any available 3- or 4-credit relevant elective course offered online through the SWAYAM platform.(Course Code: EC-DSEC-60103).

3. Foundations of Cyber-Physical Systems
4. Foundations of Cryptography
5. Sensors and Actuators

DSEC: Elective - VI

1. EC-DSEC-60201 Image Processing for Computer Vision
2. EC-DSEC-60202 Social Robotics
3. EC-DSEC-60203 MIMO Communication Systems

   Students are encouraged to select any one of the following 3- or 4-credit elective courses. Alternatively, they may opt for any available 3- or 4-credit relevant elective course offered online through the SWAYAM platform.(Course Code: EC-DSEC-60204).

4. Deep Learning for Visual Computing
5. GPU Architectures and Programming
6. Cloud Computing

DSEC: Elective - VII

1. EC-DSEC-60301 Spoken Language Identification Techniques
2. EC-DSEC-60302 Millimeter-wave and Terahertz Techniques

   Students are encouraged to select any one of the following 3- or 4-credit elective courses. Alternatively, they may opt for any available 3- or 4-credit relevant elective course offered online through the SWAYAM platform.(Course Code: EC-DSEC-60303).

3. Architectural Design of Digital Integrated Circuits
4. Introduction To Industry 4.0 And Industrial Internet Of Things
5. Communication Networks
6. Biophotonics

1.5 Semester: IV

Branch: *Electronics & Communication Engineering* **Year:** II **Semester:** IV

Sl. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					**Credits**
Theory			**L**	**T**	**P**	**TA**	**CT**	**ST**	**ESE**	**TOT**	
1	EC-PC-604	Dissertation-II	-	-	32	80	80	160	240	400	16
1	EC-PC-605	Viva-Voce	-	-	-	40	-	40	60	100	4
		Total	**-**	**-**	**32**	**120**	**80**	**200**	**300**	**500**	20

L - Lecture **T -** Tutorial **P -** Practical **TA -** Assesment by Teacher
CT - Class Test **ST -** Sub-Total **ESE -** End Semester Evaluation **TOT -** Total

Contact Hours: *32* **Total Marks:** *500* **Total Credits:** *20*

* The Project evaluation will be done based on the following components:

1. Problem Identification and Review of Related Literature
2. Proposal Writing and Presentation
3. Data Collection
4. Data Analysis, Interpretation, and Discussion
5. Report Writing
6. Viva-Voce

Students can also select MOOC courses of equivalent credit under the SWAYAM platform against Discipline Specific Elective Courses and Research Methodology (Applicable to Semesters I, II & III.)

2. M. Tech. Syllabus

2.1 First Semester

2.1.1 EC - CC-500 Advanced Signal Processing

L	-	T	-	P		
3	-	1	-	0	=	4

Course Code	:	$EC - CC - 500$
Course Name	:	*Advanced Digital Signal Processing.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To describe the multirate systems and filter banks. The paper at last focusses various wavelet transforms.

Objectives: On completion of the paper, students should

CO1: Understand various forms of sampling alteration devices

CO2: Understand filter banks and their significance

CO3: Understand Hilbert and wavelet transforms

Unit-I: Multirate Signal Processing: Sampling Rate Conversion; Decimation and Interpolation; Time and Frequency Domain Characterization; Filters in Sampling Rate Alteration Systems; Multirate Design of Decimator and Interpolator; Poly-phase Techniques; Poly-phase Down-sampler and Interpolator; Poly-phase Filter Design.

Unit-II: Filter Banks: Two-channel QMF Banks, Alias free FIR and IIR QMF Banks; Perfect Reconstruction Two-channel FIR Filter Banks; M-Channel Filter Banks Design; Cosine-Modulated M-Channel Filter Banks Design

Unit-III: Discrete Hilbert Transforms: Real and Imaginary Part, Sufficiency of the FT for Causal Sequences, Sufficiency Theorems for Finite length Sequences, Relationship between Magnitude and Phase, HT Relation for Complex Sequences.

Unit-IV: Wavelet Transforms: Fourier Transform and Its limitations, Short-Time Fourier Transform, Continuous Wavelet Transform, Discretization of the Continuous Wavelet Transform, Multiresolution Approximations; Wavelet and Scaling Function Coefficients, Harr Wavelets, The Daubechies Wavelets Construction, Fast Wavelet Transform and Image Compression, Denoising using Wavelets, Perfect Reconstruction Filter bank design using Wavelets.

Text Books:

1. S. K. Mitra, *Digital Signal Processing: A Computer Based Approach*, 4/e, TMH, 2013.
2. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 4/e, Pearson Education Inc., 2007.
3. M. Vetterli and J. Kovacevic, *Wavelets and Subband Coding*, CreateSpace Independent Publishing Platform, 2013.
4. G. Strang and T. Nguyen, *Wavelets and Filter Banks*, Wellesley Cambridge Press, 1996.

Reference Books:

1. A.V. Oppenheim and R. W. Schafer, *Discrete – Time Signal Processing*, 3/e, Prentice-Hall, 2009.
2. R. E. Crochiere and L. R. Rabiner, *Multirate Digital Signal Processing*, Prentice-Hall Inc., 1983.
3. C.K.Chui, *Wavelets: A tutorial in Theory and Applications*, Academic Press.
4. C. S. Burrus, R. A. Gopinath and H. Guo, *Introduction to Wavelets and Wavelets Transforms*, Prentice Hall Inc., 1997.

L	-	T	-	P		
3	-	1	-	0	=	4

2.1.2 EC -CC- 501 Machine Learning

Course Code	:	$EC-CC-501$
Course Name	:	*Machine Learning*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To develop a strong foundation in machine learning and enable students to apply ML techniques to signal processing, communication, and embedded systems.

Objectives: On completion of this paper, students should

CO1: Understand core concepts and mathematical foundations of ML

CO2: Have a strong foundation in machine learning methodologies, mathematics, and algorithms.

CO3: To mathematically analyze various machine learning approaches and paradigms

CO4: Able to evaluate and deploy ML models in real-world systems

Unit-I: Foundations of Machine Learning: Introduction to Machine Learning - Types (Supervised, Unsupervised, Reinforcement Learning); Applications in ECE (signal processing, communications, IoT); Data preprocessing and feature engineering; Mathematical foundations - Linear algebra (vectors, matrices), Probability and statistics, Optimization basics (gradient descent).

Unit-II: Supervised Learning: Regression - Linear, Ridge, Lasso; Classification - Logistic regression, k-NN, Naive Bayes; Support Vector Machines (SVM); Decision Trees and Random Forests; Model evaluation - Cross-validation, bias-variance trade-off; Performance metrics - Accuracy, Precision, Recall, F1-score.

Unit-III: Unsupervised Learning and Deep Learning: Clustering - k-means, hierarchical clustering; Dimensionality reduction - PCA, LDA Anomaly detection; Introduction to Neural Networks - Perceptron, MLP, backpropagation; CNN and RNN basics (applications in signal/image processing).

Unit-IV: Machine Learning for ECE Applications: ML in signal processing (filtering, prediction); ML in communication systems (channel estimation, modulation classification); Edge AI and TinyML concepts; Model optimization for embedded systems; Implementation using tools like TensorFlow and PyTorch; Case studies in IoT and real-time systems.

Text Books:

1. Tom M. Mitchell, *Machine Learning*, 2/e, McGraw Hill, 2010.
2. Alpaydin Ethem, *Introduction to Machine Learning*, 2/e, MIT Press, 2010.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Sringer, 2006.
4. Kavin. P. Murphy, *Machine Learning: A Probabilistic Perspective*, The MIT Press, 2012.
5. Aurélien Géron, *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*, OŔeilly Media, Inc., 2022.

Reference Books:

1. P. Flach, *Machine Learning: The Art and Science of Algorithms that Make Sense of Data*, Cambridge University Press, 2012.
2. David J. C. MacKay, *Information Theory, Inference, and Learning Algorithms*, the South Asia Edition, Foundation Books, 2003.
3. S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3/e, Pearson Education, 2015.
4. M. Mohri, A. Rostamizadeh and A. Talwalkar, *Foundations of Machine Learning* the MIT Press, 2012.
5. Bengio Yoshua, Ian Goodfellow, and Aaron Courville, *Deep learning*, Vol. 1. Cambridge, MA, USA: MIT press, 2017.
6. C. E. Ball Rasmussen and C. K. I. Williams, *Gaussian Processes for Machine Learning*, the MIT Press,2006.
7. R. O. Duda, P.E. Hart and D.G. Stork, *Pattern Classification*, 2/e, Wiley & Sons, 2006.

L	-	T	-	P		
3	-	1	-	0	=	4

2.1.3 EC-DSEC-50201 Wireless Communication

Course Code	:	$EC - DSEC - 50201$
Course Name	:	*Wireless Communication*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To get a well-defined apprehension of modern wireless communication systems which will help the students to design and evaluate wireless systems theoretically.

Objectives: On completion of this paper, students should

CO1: Understand fundamentals of wireless communication

CO2: Know about various propagation methods, Channel models, capacity calculations, multiple antennas and multiple user techniques used in mobile communication.

CO3: Able to mathematically analyze various methods of performance evaluation of communication systems.

Unit I: Introduction to Cellular Communication: History of cellular communication, frequency reuse, multiple access technologies, channel assignment strategies, handoff strategies, interference and system capacity, trunking and grade of services, trends in cellular radio and personal communication.

Unit II: Wireless Channel and Fading: Slow and fast fading wireless channel modeling, Rayleigh and Ricean fading channels, BER performance in fading channels.

Unit III: Diversity Techniques: Diversity techniques for wireless communications, basic methods of diversity combining, BER performance improvement with diversity, types of diversity – frequency, time, and space diversity.

Unit IV: Advanced Digital Communication Techniques: Model of spread spectrum digital communication system, direct sequence spread spectrum signals, frequency hopped spread spectrum signals, other types of spread spectrum signals, introduction to MIMO, MIMO channel capacity, singular value decomposition (SVD) and eigenmodes of the MIMO channel, introduction to OFDM, multicarrier modulation and cyclic prefix, channel model and SNR performance, OFDM issues – PAPR.

Text Books:

1. T. S. Rappaport, *Wireless Communication: Principles and Practice*, Prentice-Hall of India, 2007.
2. Andreas F. Molisch, *Wireless Communications*, Wiley-IEEE Press, 2007.
3. S. Haykin, *Communication Systems*, Wiley India, 2006.
4. Arogyaswami Paulraj, *Introduction to Space-Time Wireless Communications*, Cambridge University Press, 2006.

Reference Books:

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2005.
2. David Tse and Pramod Viswanath, *Fundamentals of Wireless Communications*, Cambridge University Press, 2005.
3. Mischa Schwartz, *Mobile Wireless Communications*, Cambridge University Press, 2005.
4. J. G. Proakis and M. Salehi, *Digital Communications*, 5/e, McGraw-Hill International Edition, 2008.

L - T - P
3 - 1 - 0 = 4

2.1.4 EC-DSEC-50202 Microwave Theory and Techniques

Course Code	:	$EC - DSEC - 50202$
Course Name	:	*Microwave Theory and Techniques*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To understand the significance of microwave theory and to design modern microwave components.

Objectives: On completion of this paper, students should be able to:

CO1: Develop the concept of microwave transmission lines and networks.

CO2: Design matching circuits and other planar microwave components.

CO3: Design filters for modern communication systems.

Unit I: Transmission Line and Networks: Review of electromagnetic field equations, wave equation and its solutions, radio frequency transmission line theory, Telegrapher's equations, concept of voltage and current waves in a line, characteristic impedance and admittance, power flow in a transmission line, terminated lines (short-circuited and open-circuited), matrix representation of networks (impedance, admittance, and ABCD matrices), matching of transmission lines (quarter-wave transformer, stub matching), introduction to left-handed transmission lines.

Unit II: Planar Transmission Lines and Passive Components: Microstrip line (EM field distribution, effective dielectric constant, characteristic impedance), coplanar waveguide, stripline, microwave resonators (series and parallel resonant circuits, transmission line resonators, dielectric resonators), microwave passive components (planar power divider, T-junction power divider, Wilkinson power divider), directional couplers (90-degree hybrid, 180-degree hybrid, Lange coupler), ferrimagnetic components (ferrite phase shifter, isolator, circulator).

Unit III: Microwave Filters: Periodic structures, filter design by insertion loss method, maximally flat and Chebyshev filter design, stepped impedance low-pass filters, band-pass and high-pass filters, filters using coupled line resonators, multiband and broadband techniques in modern filter applications.

Unit IV: Advanced Microwave Concepts: Introduction to electromagnetic metamaterials, transmission line approach to metamaterials, applications in microwave engineering, modern trends in microwave circuit design and applications.

Text Books:

1. D. M. Pozar, *Microwave Engineering*, 4/e, John Wiley, 2011.
2. Peter A. Rizzi, *Microwave Engineering: Passive Circuits*, Prentice Hall, 1987.
3. C. Caloz and T. Itoh, *Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications*, John Wiley and Sons, 2006.
4. S. M. Liao, *Microwave Devices and Circuits*, 3/e, Pearson Education, 2003.
5. Jia-Sheng Hong, *Microstrip Filters for RF/Microwave Applications*, 2/e, John Wiley and Sons, 2011.

Reference Books:

1. R. E. Collin, *Foundations for Microwave Engineering*, 2/e, Wiley-IEEE Press, 2000.
2. R. Ludwig and G. Bogdanov, *RF Circuit Design: Theory and Applications*, 2/e, Prentice Hall, 2008.

L	-	T	-	P		
3	-	1	-	0	=	4

2.1.5 EC-DSEC-50203 Silicon Photonics

Course Code	:	$EC - DSEC - 50203$
Course Name	:	*Silicon Photonics*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To design Silicon Photonics (SiPh) technology-based interferometers (MZI/MRR/Michelson) with given specifications for data-centre interconnect and communication applications.

Objectives: On completion of this course, students should be able to:

CO1: Recognize and explain Silicon Photonics (SiPh) as an emerging technology to meet explosive bandwidth demand and computationally efficient systems

CO2: Model SiPh technology-based passive photonic devices (strip waveguides, Y-branch, directional couplers, etc.)

CO3: Design the layout of passive photonic devices on an open-source GDS-II platform (KLayout) using SiEPIC tools and PDKs

CO4: Evaluate the performance of MZI/MRR/Michelson interferometers for interconnects and PIC applications with given specifications

Unit I: Introduction to Silicon Photonics (SiPh): Fabless Silicon Photonics, History of Silicon Photonics, Application of SiPh in data-center interconnects and communication (including AI-driven 1.6T links), Technical challenges and state-of-the-art in SiPhPIC fields, Career opportunities in SiPhPIC engineering, Multi-Project Wafer (MPW) services. Current trends in Co-Packaged Optics (CPO).

Unit II: Modelling and Design Approaches: Introduction to mode solvers, Physical layout tools, Introduction and application of KLayout (open-source) for GDS-II design, Design workflow. Optical materials and waveguides: SOI platform, slab and strip waveguides, 1-D and 2-D mode profile calculations, compact waveguide models, strip and bend waveguide losses.

Unit III: SiPh-based Passive Devices and Photonic Circuits: Directional couplers, Design of Y-branch, strip waveguide grating, Optical I/O devices – grating and edge couplers, Tapers and bends. Derivation of transfer functions of MZI, MRR, Michelson interferometer (design, comparison with MZI), Waveguide Bragg grating filters.

Unit IV: Design of SiPh-based Circuits on SOI: Design of MZI as switch and power attenuator, Lattice filter, Multiplexer/Demultiplexer using SiEPIC PDK on KLayout, DRC check, circuit simulation and characterization. Design for Manufacturability: Fabrication tolerances, process variation analysis, yield considerations, MPW submission best practices.

Mini-Project (compulsory for TA marks): Design, layout (GDS-II) and simulate one interferometer (MZI/MRR/Michelson) meeting given specifications using SiEPIC PDK. Submit layout file and report.

Text Books:

1. Lukas Chrostowski and Michael Hochberg, *Silicon Photonics Design: From Devices to Systems*, Cambridge University Press, 2016.
2. Slawomir Sujecki, *Photonics Modeling and Design*, CRC Press, 2015.
3. Daryl Inniss and Roy Rubenstein, *Silicon Photonics – Fuelling the Next Information Revolution*, 1/e, 2016, Morgan Kaufmann.
4. David J. Lockwood and Lorenzo Pavesi, *Silicon Photonics IV: Innovative Frontiers*, Springer, 2021.

Reference Books:

1. Lorenzo Pavesi and David J. Lockwood, *Silicon Photonics, Topics in Applied Physics* , (TAP, Vol.94), 1/e, 2004, Springer Berlin, Heidelberg.
2. Graham T. Reed and Andrew P. Knights, *Silicon Photonics: An Introduction*, 1/e, Wiley, 2004.
3. David J. Lockwood and Lorenzo Pavesi, *Silicon Photonics II: Components and Integration*, 1/e, 2010, Springer.
4. *IEEE Journals of Photonics Technology Letters, JLT, Sec. Topics in Quantum Electrons* etc.
5. Tools: Matlab ,Comsol Multiphysics (*https://www.istem.gov.in/rd-infrastructure-map/software-Through-ISTEM*), Ansys Lumerical.
6. Tools: Python, KLayout, SiEPIC tools, and pdk (*https://github.com/SiEPIC*).

L	-	T	-	P		
3	-	1	-	0	=	4

2.1.6 EC-DSEC-50301 Digital IC Design

Course Code	:	*EC − DSEC −* 50301
Course Name	:	*Digital IC Design*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To understand synthesis, optimization, verification, and testing of digital circuits.

Objectives: On completion of this course, students should be able to:

CO1: Understand the digital design flow.

CO2: Discuss techniques for synthesis of digital circuits.

CO3: Understand testing of digital circuits.

CO4: Understand verification of digital circuits.

Unit I: Digital Design Flow and CAD Tools: Introduction to digital VLSI design flow, specification, high-level synthesis, RTL design, logic optimization, verification and test planning, design representation, hardware-specific transformations.

Unit II: High-Level Synthesis: Scheduling, allocation, and binding: problem specification, basic scheduling algorithms (time-constrained and resource-constrained), allocation steps (unit selection, functional unit binding, storage binding, interconnect binding), allocation techniques (clique partitioning, left-edge algorithm, iterative refinement).

Unit III: Logic Synthesis and Optimization: Logic optimization and synthesis, heuristic minimization of two-level circuits (Espresso), finite state machine synthesis, multi-level logic synthesis and minimization, technology mapping, binary decision diagrams (BDD): introduction, construction, reduction rules, ROBDDs, operations on BDDs, representation of sequential circuits.

Unit IV: Verification and Testing: Introduction to verification, specification and modelling, model checking algorithms, symbolic model checking, automata theory in verification, automata-theoretic model checking. Digital testing: fault simulation, testability measures, combinational circuit test pattern generation, sequential circuit testing and scan chains, built-in self-test (BIST).

Text Books:

1. G. De Micheli, *Synthesis and Optimization of Digital Circuits*, Tata McGraw-Hill Education, 2003.
2. D. D. Gajski, N. D. Dutt, A. C.-H. Wu and S. Y.-L. Lin, *High-Level Synthesis: Introduction to Chip and System Design*, Springer, 1992.
3. M. Huth and M. Ryan, *Logic in Computer Science: Modelling and Reasoning about Systems*, 2/e, Cambridge University Press, 2004.

Reference Books:

1. M. L. Bushnell and V. D. Agrawal, *Essentials of Electronic Testing for Digital, Memory and Mixed-Signal Circuits*, Kluwer Academic Publishers, 2000.

L	-	T	-	P		
3	-	1	-	0	=	4

2.1.7 EC-DSEC-50302 ARM Processor and Applications

Course Code	:	$EC - DSEC - 50302$
Course Name	:	*ARM Processor and Applications*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: This course will discuss the basic concepts of embedded system design, with particular emphasis on system design using ARM microcontrollers.

Objectives:

CO1: To familiarize with the concepts of embedded system designs and the system design using ARM processors.

CO2: This course will also help to understand the developmental aspects of Internet of Things (IoT) based designs.

CO3: To understand the architectures of advanced processors.

CO4: To be able to carry out application-based experiments with advanced processors.

Unit I: ARM Processor Fundamentals and Instruction Sets: ARM embedded systems, Processor Fundamentals, Instruction Set, and Thumb Instruction Set. Assembler directives.

Unit II: ARM System Architecture and Memory Management: Assembly coding, Memory System, MMU, Protection unit, Interrupts and Exceptions. ARM system architecture.

Unit III: On-Chip Bus Architecture and Cortex-M Systems: AMBA Architecture, JTAG, Cortex-M3 architecture, OS support features; fault handling.

Unit IV: Real-Time Systems and Embedded Application Development: Programming with Real Time Operating Systems, Application programming. Programming with FreeRTOS.

Text Books:

1. F. Vahid and T. Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley India Pvt. Ltd., 2002.
2. A.N. Sloss, D. Symes and C. Wright, *ARM System Developer's Guide: Design and Optimizing System Software*, Morgan Kaufman Publishers, 2004.
3. W. Wolf, *Computers as Components: Principles of Embedded Computing System Design*, Morgan Kaufman Publishers, 2008.
4. Steve Furber, *ARM System-on-Chip Architecture*, 2/e, Addison-Wesley Professional, 2001.

Reference Books:

1. Joseph Yiu, *The Definitive Guide to the ARM Cortex-M0*, Elsevier, Newnes, 2011.
2. Dr. Alexander G. Dean, *Embedded Systems Fundamentals with ARM Cortex-M Based Microcontrollers: A Practical Approach*, ARM Education Media, 2017.
3. Qing Li, *Real-Time Concepts for Embedded Systems*, CMP Books, Elsevier, 2003.
4. Richard Barry, *Mastering the FreeRTOS Real Time Kernel: A Hands-on Tutorial Guide*, 2016.
5. *https://www.freertos.org/*

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2.1.8 EC-GEC-50401 Biosensors and Applications

Course Code	:	$EC - GEC - 50401$
Course Name	:	*Biosensors and Applications*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: This course aims to equip students with advanced knowledge of microtechnology, enabling the design, simulation, fabrication, and application of sensors and microsystems for real-world and interdisciplinary applications.

Objectives:

CO1: To understand advanced microfabrication techniques and cleanroom processes for sensor and actuator development.

CO2: To design, simulate, and analyze microsensors and microactuators using modern tools.

CO3: To develop sensor interfacing systems and apply them in real-world and IoT-based applications.

CO4: To explore emerging trends such as biosensors, microfluidics, and additive manufacturing.

Unit I: Fundamentals of Sensors, Actuators, and Microfabrication: Overview of transducers, sensors, and actuators; classification and performance characteristics; energy transformation principles; materials for microsystems (silicon, polymers, piezoelectric materials); cleanroom protocols and safety; microfabrication techniques (oxidation, diffusion, ion implantation, thin film deposition, etching); introduction to MEMS/NEMS; sensor interfacing basics; Arduino/embedded interfacing for sensors and actuators.

Unit II: Modelling, Simulation, and Characterization: Introduction to multiphysics modelling; COMSOL Multiphysics environment; modelling of thermal, mechanical, and electrostatic sensors and actuators; microheaters and thermal actuators; surface profilometry and characterization techniques; physical and chemical vapor deposition (PVD/CVD); gas sensor design and implementation; performance metrics and calibration.

Unit III: Microfabrication Processes and Signal Conditioning: Photolithography (UV, E-beam) and mask design; MEMS fabrication process flow; bulk and surface micromachining; signal conditioning circuits for temperature, pressure, and chemical sensors; noise, filtering, and amplification; data acquisition systems; introduction to biomedical cleanroom applications and packaging of MEMS devices.

Unit IV: Emerging Trends in Microsystems and Intelligent Sensing: Biosensors and electrochemical sensing; MEMS-based biomedical devices (e.g., catheter force sensors); microfluidics and lab-on-chip systems; introduction to Edge AI and TinyML for sensor data processing; integration of sensors with IoT platforms; fundamentals of additive manufacturing (3D printing) for microsystems; materials and remote prototyping; case studies of smart sensing systems.

Text Books:

1. Hardik J. Pandya, *Sensors and Actuators*, IISc Bangalore, 2022.
2. Marc J. Madou, *Fundamentals of Microfabrication and Nanotechnology*, CRC Press, 2018.
3. Nadim Maluf and Kirt Williams, *An Introduction to Microelectromechanical Systems Engineering*, 2/e, 2004.

Reference Books:

1. Julian W. Gardner, K. Varadan Vijay, and O. Awadelkarim Osama, *Microsensors, MEMS, and smart devices*, John Wiley & Sons, Inc., 2003.
2. Gregory T. Kovacs, *Micromachined transducers sourcebook*, Vol. 2. New York: WCB/McGraw-Hill, 1998.
3. Pallas-Areny, Ramon, and John G. Webster, *Sensors and signal conditioning*, John Wiley & Sons, 2012.
4. Nguyen, Nam-Trung, Steven T. Wereley, and Seyed Ali Mousavi Shaegh, *Fundamentals and applications of microfluidics*, Artech house, 2019.
5. Buerk, Donald G. *Biosensors: Theory and applications*, CRC Press, 2014.

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2.1.9 EC-GEC-50402 Microfabrication and MEMS Sensors for Clinical Applications

Course Code	:	*EC − GEC − 50402*
Course Name	:	*Microfabrication and MEMS Sensors for Clinical Applications*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To provide a comprehensive understanding of microtechnology and its application in the design, simulation, and fabrication of sensors and microsystems, with emphasis on clinical and biomedical applications.

Objectives: On completion of this paper, students should:

CO1: Understand advanced microfabrication processes, cleanroom classifications, and sensors used in electronic and biomedical applications.

CO2: Analyze and design process flows for microheaters and gas sensors using microengineering principles.

CO3: Develop fabrication strategies for force sensors and other MEMS devices for biomedical applications.

CO4: Understand and apply fabrication techniques for microfluidic platforms, flexible sensors, and integrated microsystems for clinical research.

Unit I: Microengineering Devices and Cleanroom Technology: Introduction to microengineering devices and MEMS/NEMS; classification and performance parameters of sensors and actuators; cleanroom technology—standards (Class 1–10000), contamination sources, control strategies, and safety protocols; wafer cleaning techniques (RCA cleaning, DI water rinsing, removal of organic and metallic contaminants); materials for microfabrication (silicon, polymers, metals, piezoelectric materials); overview of microheaters, force sensors, and microfluidic devices; specifications and clinical applications.

Unit II: Lithography, Patterning, and Etching: Mask design and fabrication; types of masks; photoresists (positive, negative, SU-8); spin coating and thickness control; lithography techniques—optical, X-ray, and electron-beam lithography; soft lithography and PDMS-based fabrication; process steps: pre-baking, alignment, exposure, post-exposure baking, and development; lift-off techniques; etching methods—isotropic and anisotropic etching, wet chemical etching, dry etching (RIE, DRIE), plasma-assisted processes; selectivity, etch rate, and process optimization.

Unit III: Materials, Deposition, and Process Integration: Wafer types (Si, SOI) and crystallographic orientations; thin-film deposition techniques—physical vapour deposition (DC, RF, magnetron sputtering), thermal and e-beam evaporation; chemical vapour deposition (LPCVD, PECVD) and atomic layer deposition (ALD); dielectric and conductive thin films; stress and adhesion issues; process integration and design of fabrication workflows; case studies: process flow for microheaters, force sensors, and microfluidic devices; wafer dicing, bonding (anodic, fusion, polymer bonding), and packaging of microsystems.

Unit IV: Advanced Microsystems and Biomedical Applications: Fabrication of flexible and wearable force sensors; VOC and gas sensor platforms; biochips and lab-on-chip systems; microfluidics for drug delivery and diagnostics; microcantilevers and biosensing techniques; integration of sensors with embedded and IoT systems; reliability, testing, and calibration; emerging trends—3D printing for microsystems, soft electronics, and intelligent sensing systems for healthcare applications.

Text Books:

1. J. D. Plummer, M. D. Deal, and P. G. Griffin, *Silicon VLSI Technology*, Pearson Education, 2001.
2. S. A. Campbell, *The Science and Engineering of Microelectronic Fabrication*, Oxford University Press, 2001.
3. S. M. Sze (Ed.), *VLSI Technology*, 2nd Edition, McGraw-Hill, 1988.
4. Stephen D. Senturia, *Microsystem Design*, Kluwer Academic Publishers, 2001.

Reference Books:

1. M. Gad-el-Hak (Ed.), *The MEMS Handbook*, CRC Press, 2002.
2. Marc J. Madou, *Fundamentals of Microfabrication and Nanotechnology*, CRC Press, 2018.
3. Nadim Maluf and Kirt Williams, *An Introduction to Microelectromechanical Systems Engineering*, 2/e, 2004.
4. Julian W. Gardner et al., *Microsensors, MEMS, and Smart Devices*, John Wiley & Sons, Inc., 2003.

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2.1.10 EC-GEC-50403 Biomedical Instrumentation

Course Code	:	$EC - GEC - 50403$
Course Name	:	*Biomedical Instrumentation*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To obtain a broad overview of various methods applied to biomedical instrumentation useful for healthcare.

Objectives:

CO1: Understand anatomy and physiology of the human body and its response when interfaced with instruments.

CO2: Analyse measurement of bioelectric potentials and associated instruments.

CO3: Investigate invasive and non-invasive measurement techniques with their merits and demerits.

CO4: Categorise medical imaging systems and justify their use in hospital facility design.

Unit I: Physiological systems and signals: Biology of human heart, circulatory and respiratory systems, fundamentals of human brain and nervous system, origin of bioelectric signals, electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG).

Unit II: Transducers and signal conditioners: Electrodes for ECG, EEG, EMG, microelectrodes, different types of transducers and their selection for biomedical applications, pre-amplifiers, instrumentation amplifier, biomedical filters, recorders for ECG, EEG and EMG systems.

Unit III: Instrumentation for clinical laboratory: Measurement of pH value of blood, hemoglobin measurement, oxygen and carbon dioxide measurement, design of therapeutic equipment such as cardiac pacemaker, cardiac defibrillator, ventilators, hemodialysis machine.

Unit IV: Medical imaging and patient monitoring systems: X-ray imaging, computed tomography, ultrasonic imaging, magnetic resonance imaging, intensive cardiac care, patient monitoring through biotelemetry, bedside and central monitoring systems.

Text Books:

1. L. Cromwell, F. J. Weibell, E. A. Pfeiffer, and L. B. Usselman, *Biomedical Instrumentation and Measurements*, Prentice-Hall, 1973.

Reference Books:

1. R. S. Khandpur, *Handbook of Biomedical Instrumentation*, McGraw-Hill Education, 2014.
2. J. Enderle, S. Blanchard, and J. Bronzino, *Introduction to Biomedical Engineering*, Academic Press, 2001.

2.2 Second Semester

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2.2.1 EC-CC-505 Advanced Wireless and Digital Communication.

Course Code	:	$EC - CC - 505$
Course Name	:	*Advanced Wireless and Digital Communication.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To develop a comprehensive understanding of modern digital and wireless communication systems, enabling students to model, analyse, and evaluate next-generation communication techniques.

Objectives:

CO1: Understand signal space representation and advanced digital modulation techniques.

CO2: Analyse channel impairments such as fading, ISI, and their mitigation techniques.

CO3: Understand multiple access, spread spectrum, and multi-antenna communication systems.

CO4: Evaluate performance of modern wireless systems such as MIMO and OFDM.

Unit I: Signal space representation and digital modulation: Geometric representation of signals, linear modulation techniques (BPSK, QPSK, OQPSK), constant envelope modulation (MSK, GMSK), M-ary PSK and QAM, advantages and limitations of modulation schemes, error performance in AWGN channels.

Unit II: Channel impairments and equalization: Band-limited channels, inter-symbol interference (ISI), Nyquist criterion, controlled ISI, linear and adaptive equalizers, adaptive equalization algorithms, nonlinear equalizers, maximum likelihood sequence estimation (MLSE), introduction to wireless channel models, Rayleigh and Ricean fading, BER performance and diversity techniques (maximal-ratio combining).

Unit III: Spread spectrum and multiple access techniques: Spread spectrum systems, direct sequence spread spectrum (DSSS), frequency hopping spread spectrum (FHSS), pseudo-noise sequences, CDMA principles, code properties, multi-user CDMA analysis, near-far problem, multipath diversity in CDMA systems.

Unit IV: Advanced wireless communication techniques: Multiple Input Multiple Output (MIMO) systems, transmit diversity and space-time block coding (Alamouti scheme), beamforming, singular value decomposition (SVD) in MIMO, Orthogonal Frequency Division Multiplexing (OFDM), multicarrier transmission, FFT/IFFT processing, cyclic prefix, system-level performance considerations in 4G/5G communication systems.

Text Books:

1. Stephen G. Wilson, *Digital Modulation and Coding*, Pearson Education, 1996.
2. T. S. Rappaport, *Wireless Communications*, 2/e, Pearson, 2010.
3. S. Haykin, *Digital Communication*, Wiley Student Edition, 2006.

Reference Books:

1. J. G. Proakis and M. Salehi, *Digital Communication*, 5/e, McGraw-Hill Publication, 2008.

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2.2.2 EC-CC-506 Advanced System Design Laboratory.

Course Code	:	$EC - CC - 506$
Course Name	:	*Advanced System Design Laboratory.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 20, End Semester Examination = 30.*
Questions to be Set	:	*Minimum Ten*
Questions to be Answered	:	*Any 1 (One) on Lottery Basis.*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: The main aim of this course is to give an in-depth understanding of the Digital Designs in an FPGA.

Objectives: On completion of this paper, students will be able to:

CO1: Design and implement digital systems using FPGA platforms, and synthesize hardware modules using HDL for high-performance applications.

CO2: Design and implement embedded systems using Arduino and Raspberry Pi for sensing and control applications.

CO3: Develop intelligent embedded solutions using edge computing and basic AI techniques.

Hands-on/ Laboratory/ Practical:

Track A: FPGA Implementation Laboratory

1. FPGA toolchain study and LED interfacing in FPGA.
2. Combinational logic design (MUX/Decoder) in FPGA.
3. Sequential circuit design (Flip-flops) in FPGA.
4. Sequential circuit design (Shift Registers and Counters) in FPGA.
5. State Machine Implementation implementation in FPGA.
6. ALU design in FPGA.
7. Translation of High-Level Codes for FPGA.
8. FPGA System Emulation.

Track B: Embedded and Intelligent Systems Laboratory

1. Study of digital and analog I/O interfacing and signal analysis (*Platform: Arduino*).
2. Design and implementation of a real-time multi-sensor data acquisition system (*Platform: Arduino*).
3. Implementation of actuator control (DC/Servo motor) with feedback mechanism (*Platform: Arduino*).
4. Study and implementation of serial communication protocols (UART, I2C, SPI) (*Platform: Arduino*).
5. Interfacing and data communication between Arduino and Raspberry Pi.
6. Design of an IoT-based system for remote monitoring and control (*Platform: Arduino / ESP8266 + Raspberry Pi*).
7. Configuration and interfacing of Raspberry Pi (GPIO control using Python).
8. Implementation of image processing techniques using OpenCV (*Platform: Raspberry Pi*).

Text Books:

1. Donald Thomas, *Logic Design and Verification Using System Verilog*, 2016.
2. Frank Bruno, *FPGA Programming for Beginners*, Springer, 2021.
3. Edward Ashford Lee and Sanjit Arunkumar Seshia, *Introduction to Embedded Systems: A cyber-physical systems approach*, MIT press, 2016.
4. Jeremy Blum, *Exploring Arduino: tools and techniques for engineering wizardry*, John Wiley & Sons, 2019.
5. Simon Monk, *Raspberry Pi Cookbook*, OŔeilly Media, Inc., 2022.

Reference Books:

1. Justin Rajewski, *Learning FPGAs*, Springer, 2017.
2. Elecia White, *Making Embedded Systems*, OŔeilly Media, Inc., 2024.

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2.2.3 EC-DSEC-50701 Advanced Communication Practices.

Course Code	:	$EC - DSEC - 50701$
Course Name	:	*Advanced Communication Practices.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 20, End Semester Examination = 30.*
Questions to be Set	:	*Minimum Ten*
Questions to be Answered	:	*Any 1 (One) on Lottery Basis.*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To develop a communication engineer who can model and design the laboratory based prototype communication devices, circuit and system as per given specifications.

Objectives: On completion of this paper, students would be able to:

CO1: Analyze communication channels by estimating path loss and evaluating system performance using BER and eye diagrams for various modulation schemes.

CO2: Model and design passive silicon photonic devices and photonic circuits such as Mach–Zehnder Interferometers (MZI) and Micro-Ring Resonators (MRR).

CO3: Develop and simulate complete communication links and evaluate performance in terms of bit rate, SNR, and power.

CO4: Analyze and design microstrip antennas and microwave passive circuits.

Hands-on/ Laboratory/ Practical:

1. Develop software to get the free space path loss propagation by varying the distances between the transmitter & receiver and compare the result graphically using MATLAB.
2. Develop software to get the different pattern of Rayleigh function using MATLAB.
3. Find out the BER of BPSK and higher modulation scheme over Rayleigh and Rice fading channels using Monte-Carlo simulation.
4. Find out the BER of BPSK and higher modulation scheme with selection diversity over Rayleigh and Rice fading channels using Monte-Carlo simulation.
5. Analytic calculation of 1D/2D strip waveguide mode parameters and effective index.
6. Design a uniform Bragg grating with given specifications.
7. Design Mach-Zehnder Interferometer (MZI) using SiEPIC tools and PDK on KLayout/MATLAB for given specifications.
8. Design Micro-Ring Resonator (MRR) using SiEPIC tools and PDK on KLayout/MATLAB for given specifications.
9. Measurement of impedance of an unknown load.
10. Design and simulation of microstrip antenna.
11. Design and simulation of microwave filters.
12. Study the characteristics of a microstrip antenna using advanced microstrip antenna trainer kit.

Text Books:

1. Lukas Chrostowski and Michael Hochberg, *Silicon Photonics Design: From Devices to Systems*, Cambridge University Press, 2016.
2. Slawomir Sujecki, *Photonics Modeling and Design*, CRC Press, 2015.
3. Simon Haykin, *Communication Systems*, 5th Edition, Wiley, 2009.
4. V. Protopopov, *Practical Opto-Electronics: An Illustrated Guide for the Laboratory*, Springer, 2014.
5. John G. Proakis and Masoud Salehi, *Digital Communications*, 5th Edition, McGraw-Hill, 2008.
6. T. S. Rappaport, *Wireless Communications: Principles and Practice*, 2nd Edition, Pearson, 2002.
7. C. A. Balanis, *Antenna Theory: Analysis and Design*, 3rd Edition, Wiley, 2009.

Reference Books:

1. Lorenzo Pavesi and David J. Lockwood, *Silicon Photonics*, Springer, 2004.
2. David J. Lockwood and Lorenzo Pavesi, *Silicon Photonics II: Components and Integration*, Springer, 2010.
3. Morris Tischler, *Optoelectronics: Textbook Laboratory Manual*, McGraw-Hill Inc., 1990.
4. M. L. Sisodia and G. S. Raghuvanshi, *Basic Microwave Techniques and Lab Manual*, New Age International, 1987.
5. J. D. Kraus, *Antennas*, 3/e, McGraw-Hill, 2001.

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2.2.4 EC-DSEC-50702 Advanced Practices in VLSI Devices and RF Circuits.

Course Code	:	*EC – DSEC –* 50702
Course Name	:	*Advanced Practices in VLSI Devices and RF Circuits.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 20, End Semester Examination = 30.*
Questions to be Set	:	*Minimum Ten*
Questions to be Answered	:	*Any 1 (One) on Lottery Basis.*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: The main aim of this course is to produce world-class professionals with wide knowledge in high-speed semiconductor devices and to enhance their skills in designing various modern electronic circuits.

Objectives: On completion of this paper, students should:

CO1: Understand and model advanced nano-scaled VLSI devices.

CO2: Design new architectures of MOS devices.

CO3: Understand the behavior of microwave semiconductor devices.

CO4: Design and verify the characteristics of MESFET and HEMT.

CO5: Design and simulate various modern electronic circuits.

Hands-on/ Laboratory/ Practical:

1. Implement MOSFET compact model in SPICE.
2. Design an nMOSFET device with given specifications using TCAD.
3. Design a pMOSFET device with given specifications using TCAD.
4. Design a FinFET device with given specifications using TCAD.
5. Design a Gate-All-Around (GAA) MOSFET with given specifications using TCAD.
6. Comparative simulation and analysis of short-channel effects in MOSFET, FinFET, and GAA devices using TCAD.
7. Extraction and analysis of MOSFET compact model parameters (e.g., threshold voltage, mobility, channel length modulation) from simulated I–V characteristics using SPICE/TCAD.
8. Design and verification of HEMT.
9. Design and development of an oscillator.
10. Design and development of a mixer.
11. Design and simulation of a low-noise amplifier (LNA) for RF applications using SPICE/ADS.
12. Design and simulation of a Phase-Locked Loop (PLL) or Voltage-Controlled Oscillator (VCO).
13. Simulation and characterization of S-parameters of a microwave transistor (HEMT/MESFET) using RF simulation tools.
14. Design and simulation of a microwave amplifier using HEMT/MESFET and evaluation of gain, stability, and noise performance.

Text Books:

1. Donald Neamen, *Semiconductor Physics and Devices*, 4/e, McGraw-Hill, 2021.
2. J.P. Colinge and C. A. Colinge, *Physics of Semiconductor Devices*, Springer, 2002.
3. Jean-Pierre Colinge, *FinFETs and Other Multi-Gate Transistors*, Springer, 2008.
4. B. G. Streetman and S. Banerjee, *Solid State Electronic Devices*, 7/e, Pearson Education, 2016.
5. Guillermo Gonzalez, *Foundations of Oscillator Circuit Design*, Artech House, 2006.
6. Stephen A. Maas, *Nonlinear Microwave and RF Circuits*, 2/e, Artech House, 2003.
7. Paolo Antognetti and Giuseppe Massobrio, *Semiconductor Device Modelling with SPICE*, 2/e, McGraw-Hill, 1993.

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2.2.5 EC-DSEC-50703 PIC Design Laboratory.

Course Code	:	$EC - DSEC - 50703$
Course Name	:	*PIC Design Laboratory.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 20, End Semester Examination = 30.*
Questions to be Set	:	*Minimum Ten*
Questions to be Answered	:	*Any 1 (One) on Lottery Basis.*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To develop a communication engineer who can model and design laboratory-based prototype photonic devices, circuits and systems as per given specifications.

Objectives: On completion of this paper, students should:

CO1: Calculate losses in optical waveguide and fiber, and splice two single-mode fibers.

CO2: Model and design passive Silicon Photonic based devices, and Photonic Circuits (MZI/MRR/Lattice Filter, Mux/DeMux).

CO3: Design optical communication system and determine BER.

CO4: Use SiEPIC tools and PDK to design PIC circuits.

CO5: Perform post-layout simulation and design-for-manufacturability analysis.

Hands-on/ Laboratory/ Practical:

1. Design a strip waveguide for single-mode light propagation and characterize it.
2. Calculate the bending loss in a strip waveguide for the fundamental modes TE_0 and TM_0.
3. Calculate length dependence of attenuation in the given optical fiber at different C-band wavelengths.
4. Splice two fibers and calculate the splicing loss.
5. Characterize the WDM Mux and Demux.
6. Design photonic circuit for adding and dropping channels in a WDM link.
7. Design a uniform Bragg grating with given specifications.
8. Characterize a laser diode and a photodiode.
9. Design Mach-Zehnder Interferometer (MZI) for given specification (e.g., FSR).
10. Design MZI using SiEPIC tools and PDK on KLayout for given specifications.
11. Design a Micro-Ring Resonator (MRR) using SiEPIC tools and PDK on KLayout for given specifications (FSR).
12. Post-layout circuit simulation of designed MZI/MRR using Lumerical/OptiSystem; S-parameter extraction and system-level performance evaluation.
13. Determine BER as a function of laser transmitted power (calculate bit length, noise, noise margin, jitter, sampling period).
14. Design a lattice filter.

Text Books:

1. Lukas Chrostowski and Michael Hochberg, *Silicon Photonics Design: from Devices to Systems*, 1/e, 2016, Cambridge University Press, University Printing House, Cambridge CB2 8BS, UK.
2. Slawomir Sujecki, *Photonics Modeling and Design*, 1/e, 2015 CRC Press, Taylor and Francis Group, 6000 Broken Sound Parkway, NW, Suit 300.
3. Lorenzo Pavesi, David J. Lockwood, *Silicon Photonics, Topics in Applied Physics* (TAP, volume 94), 1/e, 2004, Springer Berlin, Heidelberg
4. Graham T. Reed and Andrew P. Knights, *Silicon Photonics: An Introduction*, 1/e, 2004, Wiley
5. David J. Lockwood and Lorenzo Pavesi, *Silicon Photonics II: Components and Integration: 119 (Topics in Applied Physics)*, 1/e, 2010, Springer
6. Morris Tischler, *Optoelectronics: Text book Laboratory Manual*, McGraw-Hill Inc., 1990.
7. V. Protopopov, *Practical Opto-Electronics: An Illustrated Guide for the Laboratory*, Springer; 2014.

Tools:

1. Matlab ,Comsol Multiphysics(*https://www.istem.gov.in/rd-infrastructure-map/software-through-istem*), Ansys Lumerical, OptiSystem, OptiBeam etc.
2. Python, KLayout, SiEPIC tools, and pdk (*https://github.com/SiEPIC*)
3. LightRunner Bench Top laboratory kit-premium
4. Fusion Splicing Machine

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2.2.6 EC-DSEC-50801 Antenna Analysis and Design.

Course Code	:	$EC - DSEC - 50801$
Course Name	:	*Antenna Analysis and Design*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To develop RF engineers who can design a variety of antennas for a wide range of applications.

Objectives: On completion of this paper, students should:

CO1: Understand the radiation mechanism and different parameters of an antenna.

CO2: Analyze and design antenna arrays.

CO3: Design various antennas for different applications.

CO4: Understand the concept of smart antennas.

Unit I: Fundamentals of antennas: Radiation mechanism, antenna parameters (radiation pattern, gain, directivity, efficiency, bandwidth, polarization), basic antenna types and their characteristics.

Unit II: Antenna arrays: Array factor for linear arrays, uniformly excited equally spaced linear arrays, pattern multiplication, directivity of linear arrays, non-uniformly excited equally spaced arrays, mutual coupling, multidimensional arrays, phased arrays, feeding techniques, perspectives on arrays.

Unit III: Microstrip antennas: Operating principle, modes of operation, field patterns, impedance, feeding techniques, polarization, design of rectangular and circular patch antennas, arrays and feed network.

Unit IV: Smart antennas: Need for smart antennas, smart antenna configurations, beamforming fundamentals, adaptive beamforming, space division multiple access (SDMA), architecture of smart antenna systems.

Text Books:

1. J. D. Kraus, *Antennas*, 3/e, McGraw-Hill, 2001.
2. C. A. Balanis, *Antenna Theory: Analysis and Design*, 3/e, John Wiley & Sons, 2009.
3. Thomas A. Milligan, *Modern Antenna Design*, 2/e, Wiley-IEEE Press, 2005.
4. Ahmed El Zooghby, *Smart Antenna Engineering*, Artech House.
5. M. J. Bronzel, *Smart Antennas*, John Wiley, 2004.

Reference Books:

1. Jordan and Balmain, *Electromagnetic Waves and Radiating Systems*, John Wiley, 2002.
2. Yi Huang and Kevin Boyle, *Antennas: From Theory to Practice*, Wiley-IEEE Press, 2008.

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2.2.7 EC-DSEC-50802 VLSI Devices and Modeling.

Course Code	:	$EC - DSEC - 50802$
Course Name	:	*VLSI Devices and Modeling.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: The reader will get acquainted with the modeling techniques of different VLSI devices.

Objectives:

CO1: To study the basic device physics required to understand the working of MOS devices.

CO2: To understand the concept of modeling of new device structures.

CO3: To apply acquired knowledge to overcome small dimensional effects.

Unit I: Basic device physics: Two-terminal MOS transistor model, flat-band voltage, potential balance and charge balance, effect of gate-substrate voltage on surface condition, inversion, small-signal capacitance. Three-terminal MOS model: contacting the inversion layer, body effect, regions of inversion, pinch-off voltage.

Unit II: Four-terminal MOS transistor model: Transistor regions of operation, general charge sheet models, regions of inversion in terms of terminal voltage, strong, weak and moderate inversion, effective mobility, temperature effects, breakdown in p-channel MOSFET, enhancement and depletion type MOSFETs, model parameters and accuracy.

Unit III: Small dimension effects: Channel length modulation, barrier lowering, two-dimensional charge sharing and threshold voltage, punch-through, carrier velocity saturation, hot carrier effects, scaling, effects of surface and drain series resistance, effects due to thin oxides and high doping, subthreshold region.

Unit IV: CMOS device design and performance: Scaling, threshold voltage, MOSFET channel length, basic CMOS circuit elements, parasitic elements, sensitivity of CMOS delay to device parameters, performance factors of advanced CMOS devices.

Text Books:

1. Yuan Taur and Tak H. Ning, *Fundamentals of Modern VLSI Devices*, 2nd ed., Cambridge University Press, 2013.
2. Yannis Tsividis, *Operation and Modeling of the MOS Transistor*, 2/e, Oxford University Press, 2003.

Reference Books:

1. S. M. Sze, *Physics of Semiconductor Devices*, 3/e, Wiley India, 2008.
2. Phillip E. Allen and Douglas R. Holberg, *CMOS Analog Circuit Design*, 2/e, Oxford University Press, 2002.

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2.2.8 EC-DSEC-50803 Modern Digital Control System

Course Code	:	$EC - DSEC - 50803$
Course Name	:	*Modern Digital Control System.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To understand the concept of discrete-time systems and to apply the theoretical concepts for designing digital control systems through different techniques.

Objectives:

CO1: To develop the knowledge of sample and hold circuits and pulse transfer functions.

CO2: To design digital controllers and evaluate the stability of the system.

CO3: To analyze and design digital control systems using state space representation.

Unit I: Introduction to discrete-time control systems: Basic building blocks of discrete-time control systems, quantization and error effects, data acquisition, conversion and distribution systems, Z-transform, inverse Z-transform, Z-transform method for solving differential equations, digital control of processes.

Unit II: Z-plane analysis of discrete-time control systems: Impulse sampling and data hold, zero-order hold (ZOH) and first-order hold (FOH), determination of pulse transfer function for cascaded elements, closed-loop digital control systems and digital PID controllers. Realization of digital controllers and digital filters: direct programming, standard programming, series and parallel programming.

Unit III: Design of discrete-time control systems: Mapping between S-plane and Z-plane, stability analysis of closed-loop systems in Z-plane, Jury stability criterion, transient and steady-state response analysis, design using root-locus method, effect of sampling period on transient response, design using frequency response method, bilinear transformation and w-plane, Bode diagrams, compensator design.

Unit IV: State space analysis, pole placement and observer design: State space representation of discrete-time systems, solving discrete-time state space equations, state transition matrix (STM), computation of STM using Z-transform method, pulse transfer function matrix, discretization of continuous-time state space equations, Lyapunov stability analysis, controllability and observability, design via pole placement, state observers.

Text Books:

1. K. Ogata, *Discrete-Time Control Systems*, 2/e, Pearson Education, 2007.
2. M. Gopal, *Digital Control and State Variable Methods*, 3/e, Tata McGraw-Hill, 2003.
3. Gene F. Franklin, Abbas Emami-Naeini and J. David Powell, *Feedback Control of Dynamic Systems*, 5/e, Pearson Education, 2008.
4. R. G. Jacquot, *Modern Digital Control Systems*, 2/e, Routledge, 2019.

Reference Books:

1. B. C. Kuo, *Digital Control Systems*, 2/e, Oxford University Press, 2003.
2. Richard H. Middleton and Graham C. Goodwin, *Digital Control and Estimation: A Unified Approach*, Prentice Hall, 1990.

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2.2.9 EC-RM-509 Research Methodology and Proposal Writing.

Course Code	:	$EC - RM - 510$
Course Name	:	*Research Methodology and Proposal Writing.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To understand how to conduct a scientific research and communicate research findings

Objectives: On completion of this course, students will be able to:

CO1: Understand the basic philosophy of science and scientific modeling.

CO2: Learn the principles of research-related statistical data analysis and hypothesis testing.

CO3: Write proposals and communicate research findings in appropriate ways.

Unit I: Basic Concepts in the Philosophy of Science: What is the meaning of science, The nature of truth, Subjective thinking, Objective thinking, Materialism and idealism, Logical reasoning: Inductive logic, Deductive logic, Falsifiability, Reproducibility, Causality.

Unit II: Mathematical Modeling of Physical Systems and Hypothesis Testing: Models built from first principles, Dimensional consistency, Modeling using dimensional analysis. Proposing hypotheses, Proposing postulates, Measuring the value of a parameter or a constant, Establishing a functional relationship.

Unit III: Statistical Data Analysis and Hypothesis testing: Sampling, Analysis of the sampled data, Distribution of the data, Measurement, and Confidence Intervals, Measurement of a value, Experimental error analysis, the Central Limit Theorem, Estimating with confidence. Forming a Hypothesis, Null and alternative hypothesis, Planning experiments for hypothesis testing, Experimental group and control group, statistical test.

Unit IV: The Art of Scientific Communication and resarch ethics: Writing a proposal and Text stylistics, Research paper writing, Revising a manuscript. Presentation in Seminars and Conferences: The art of preparing visual presentation material, The art of delivering a talk at a conference, Ethical Conduct in Science, Citation and impact of a paper, Cases of scientific misconduct.

Text Books:

1. Soumitro Banerjee, *Research Methodology for Natural Sciences*, IISc Press, 2022.

Reference Books:

1. C. R. Kothari, *Research Methodology*, 2/e, New Age International Publisher, 2002.
2. S. R. Bajpai, *Research Methodology*, S. Chand and Sons, 2001.

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2.2.10 EC-SEC-51001 Advanced Data Visualization and Analytics.

Course Code	:	$EC - SEC - 51101$
Course Name	:	*Advanced Data Visualization and Analytics.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To equip students with advanced principles and practical skills in data visualization, enabling them to design, develop, and communicate insights effectively using modern tools, Python libraries, and interactive dashboards.

Objectives: On completion of this paper, students should be able to:

CO1: Apply visualization design principles to create effective and meaningful data representations.

CO2: Develop basic to advanced visualizations using Python libraries for data exploration and analysis.

CO3: Analyze and visualize time-series, geospatial, and high-dimensional datasets to extract actionable insights.

CO4: Design interactive dashboards and data-driven stories using modern BI and visualization tools.

Unit I: Fundamentals of Data Visualization and Design: Role and importance of data visualization; cognitive aspects of visual perception; visualization design principles (clarity, accuracy, efficiency); data types and structures; data preprocessing (cleaning, transformation, aggregation); introduction to Python visualization libraries (Matplotlib, Seaborn, Plotly Express); basic charts (bar, line, histogram, scatter, box plots); color theory, accessibility, and visual encoding; introduction to advanced plots (heatmaps, pair plots, facet grids).

Unit II: Advanced Visualization Techniques and Data Types: Visualization of time-series data (trend, seasonality, decomposition); handling multiple time-series datasets; geospatial visualization (maps, choropleths, GeoJSON); visualization of high-dimensional data (PCA, t-SNE concepts); network and graph visualization basics; interactive visualizations using Plotly and Dash; case studies.

Unit III: Data Analytics and Visual Exploration: Overview of data analytics (descriptive, diagnostic, predictive, prescriptive); exploratory data analysis (EDA) using visualization; statistical summaries and hypothesis-driven visualization; integration of machine learning outputs with visualization (model evaluation plots, confusion matrix, ROC curves); storytelling with data and insight communication.

Unit IV: Business Intelligence and Interactive Dashboard Design: Introduction to business intelligence (BI) tools (Tableau, Power BI); dashboard design principles (layout, hierarchy, interactivity); creation of interactive dashboards and reports; real-time and streaming data visualization concepts; data storytelling frameworks; ethics in data visualization and avoiding misleading visuals; case studies and applications.

Text Books:

1. Wes McKinney, *Python for Data Analysis*, 2nd Edition, O'Reilly Media, 2017.
2. Tamara Munzner, *Visualization Analysis and Design*, CRC Press, 2014.
3. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media, 2016.
4. Claus O. Wilke, *Fundamentals of Data Visualization*, O'Reilly Media, 2019.

Reference Books:

1. Alberto Cairo, *The Functional Art: An introduction to information graphics and visualization*, New Riders, 2012.
2. Yau, Nathan, *Visualize this!*, John Wiley & Sons, 2013.
3. Cole Nussbaumer Knaflic, *Storytelling with data: let's practice!*, John Wiley & Sons, 2019.
4. Andy Kirk, *Data Visualisation: A Handbook for Data Driven Design*, Sage, 2016.

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2.2.11 EC-SEC-51002 Embedded System Design with Advanced Processors.

Course Code	:	$EC - SEC - 51102$
Course Name	:	*Embedded System Design with Advanced Processors.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: This course aims to provide in-depth knowledge of embedded system design using advanced processors such as ARM Cortex, RISC-V, and DSPs, with emphasis on real-time systems, embedded Linux, hardware-software co-design, and intelligent embedded applications.

Objectives:

CO1: Analyze and design embedded systems using advanced processor architectures such as ARM and RISC-V.

CO2: Develop real-time embedded applications using RTOS and embedded Linux platforms.

CO3: Apply hardware-software co-design techniques for performance and power optimization.

CO4: Design intelligent embedded systems integrating edge AI/ML techniques.

Unit I: Embedded Systems Fundamentals and Processor Architectures: Embedded system overview, classification, and design flow; real-time and IoT-based systems; evolution from microcontrollers to advanced processors; ARM Cortex (A, M, R) architecture; RISC-V fundamentals; DSP processors; pipeline, cache, and memory hierarchy; multi-core and heterogeneous architectures.

Unit II: Embedded Software Development and Real-Time Systems: Cross-compilation and toolchains (GCC, Clang); bare-metal programming; interrupts, timers, and peripheral interfacing; debugging (JTAG, GDB); RTOS fundamentals; scheduling algorithms; task management; inter-task communication; synchronization (semaphores, mutexes); case studies: FreeRTOS and Zephyr.

Unit III: Embedded Linux and Hardware–Software Co-Design: Embedded Linux architecture; kernel basics; device drivers; bootloaders (U-Boot); file systems; system configuration; Yocto/Buildroot overview; hardware-software co-design methodologies; system partitioning; FPGA-based SoC (Zynq); high-level synthesis (HLS).

Unit IV: Energy-Efficient Embedded Systems and Edge AI: Power-aware design techniques; dynamic voltage and frequency scaling (DVFS); memory and cache optimization; profiling and benchmarking; introduction to Edge AI and TinyML; deployment of ML models on embedded platforms; frameworks (TensorFlow Lite, ONNX Runtime); applications in vision, speech, IoT, and assistive systems.

Text Books:

1. Jonathan W. Valvano, *Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers*, 3rd Edition, CreateSpace Independent Publishing Platform, 2017.
2. Andrew N. Sloss, Dominic Symes, and Chris Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, Morgan Kaufmann Publishers, 2004.
3. Christopher Hallinan, *Embedded Linux Primer: A Practical Real-World Approach*, 2nd Edition, Prentice Hall, 2010.
4. Qing Li and Caroline Yao, *Real-Time Concepts for Embedded Systems*, CMP Books, 2003.
5. Pete Warden and Daniel Situnayake, *TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers*, O'Reilly Media, 2019.

References:

1. Joseph Yiu, *The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors*, 3rd Edition, Newnes (Elsevier), 2013.
2. David A. Patterson and John L. Hennessy, *Computer Organization and Design RISC-V Edition: The Hardware/Software Interface*, Morgan Kaufmann, 2017.
3. Frank Vahid and Tony Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, John Wiley & Sons, 2002.
4. Karim Yaghmour, *Building Embedded Linux Systems*, 2/e, O'Reilly Media, 2008.

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2.2.12 EC-SEC-51003 Project Management for Managers.

Course Code	:	$EC - SEC - 51103$
Course Name	:	*Project Management for Managers.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To develop essential skills required to manage projects and managerial knowledge and competencies.

Objectives: On completion of this paper, students should be able to:

CO1: Describe project life cycles, types, and methods of selecting a project.

CO2: Explain various risk management techniques and methods and plant capacity analysis.

CO3: Elaborate on project team building, HRM issues, and time management in projects.

CO4: Describe time and cost relationship, quality management, and project termination.

Unit I: Project management fundamentals: Introduction to project management, project success, types of organizational structures, project management office. Project life cycle analysis: types of projects and project life cycle. Methods of project selection, market and demand analysis, financial analysis.

Unit II: Capital budgeting techniques: Financing of projects, risk management, risk control and documentation, stand-alone risk analysis, Hillier model, simulation analysis, decision tree analysis, abandonment analysis, technical analysis, product mix and plant capacity analysis.

Unit III: Project team building: Conflict and negotiation, HRM issues, time management, project scheduling, numbering of nodes, PERT networks, laddering in PERT/CPM, probability models in networks.

Unit IV: Time and cost relationship: Crashing of networks, project cost management and estimation, quality management, sources of variability and Six Sigma, procurement management, project termination.

Text Books:

1. Roderick A. Munro, Govindarajan Ramu, and Daniel J. Zrymiak, *The Certified Six Sigma Green Belt Handbook*, ASQ Quality Press, 2017.
2. S. A. Campbell, *The Certified Six Sigma Black Belt Handbook*, Pearson, 2018.
3. Forrest W. Breyfogle III, *Implementing Six Sigma*, John Wiley & Sons, 2003.
4. Evans, J. R. and W. M. Lindsay, *An Introduction to Six Sigma and Process Improvement*, Cengage Learning, 2014.

Reference Books:

1. Howard S. Gitlow and David M. Levine, *Six Sigma for Green Belts and Champions*, Pearson, 2004.
2. D. C. Montgomery, *Design and Analysis of Experiments*, 10th ed., Wiley, 2019.
3. Amitava Mitra, *Fundamentals of Quality Control and Improvement*, 3rd ed., Wiley India, 2013.
4. D. C. Montgomery, *Statistical Quality Control: A Modern Introduction*, 7th ed., Wiley, 2013.

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2.2.13 EC-SEC-51004 PIC Design.

Course Code	:	$EC - SEC - 51004$
Course Name	:	*PIC Design.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To design Photonic Integrated Circuits (PICs) with suggested specifications for data-center interconnect and communication applications.

Objectives: On completion of this course, students should be able to:

CO1: Recognize and explain Photonic Integrated Circuits on SOI along with electronics as an emerging technology to meet explosive bandwidth demand

CO2: Model passive and active PICs on SOI platform using SiPh technology

CO3: Design layout of passive and active photonic devices on open-source GDS-II platform using SiEPIC tools and PDKs

CO4: Evaluate performance of PICs for data-center and communication applications with given specifications

Unit I: Introduction to Photonic Integrated Circuits (PICs): Review of SiPh technology and role of PICs along with integrated electronic circuits; advanced topics in planar waveguides on SOI; Hybrid integration concepts.

Unit II: Functional Photonic Passive and Active Circuits for PICs: MZI-based lattice filters, attenuators, multiplexer/demultiplexer circuits; Micro-ring Resonator (MRR) based photonic circuits. Plasma-dispersion effect, pn-junction phase shifters, thermal tuners, carrier depletion/injection modulators, Ge photodetectors on SOI, Lasers on Silicon.

Unit III: Introduction to SiEPIC Tools and PDKs: CMOS fabrication steps for passive and active PICs, GDS-II layout on KLayout, interface with SiEPIC tools, Process Design Kits (PDKs) for e-beam lithography, application in designing MZI, MRR and active devices, Design Rule Check (DRC) and simulation. Four Corner Analysis of Device performances.

Unit IV: Photonic System Design: Need for photonic circuit modelling, compact models, S-parameters of passive and active devices. PIC system examples – Ring-based WDM transmitter, SiPh-based transceiver. Photonic-electronic co-design, packaging (Co-Packaged Optics – CPO, 2.5D/3D integration), rise time and power budget analysis, energy-per-bit calculations, case study of 1.6T transceiver.

Mini-Project (compulsory for TA marks): Design and layout a complete PIC (e.g., thermo-optic phase shifter, 4-channel WDM transmitter, or 2×2 MZI switch with active tuning) using SiEPIC PDK. Submit GDS-II file, S-parameter extraction, and performance report.

Text Books:

1. Lukas Chrostowski and Michael Hochberg, *Silicon Photonics Design: from Devices to Systems*, 1/e, 2016, Cambridge University Press.
2. Slawomir Sujecki, *Photonics Modeling and Design*, 1/e, 2015, CRC Press.
3. Daryl Inniss and Roy Rubenstein, *Silicon Photonics – Fuelling the Next Information Revolution*, 1/e, 2016, Morgan Kaufmann.
4. David J. Lockwood and Lorenzo Pavesi, *Silicon Photonics IV: Innovative Frontiers*, 1/e, 2021, Springer Cham.

Reference Books:

1. Lorenzo Pavesi, David J. Lockwood, *Silicon Photonics, Topics in Applied Physics* (TAP, volume 94), 1/e, 2004, Springer Berlin, Heidelberg.
2. Graham T. Reed and Andrew P. Knights, *Silicon Photonics: An Introduction*, 1/e, 2004, Wiley.
3. David J. Lockwood and Lorenzo Pavesi., *Silicon Photonics II: Components and Integration: 119(Topics in Applied Physics)*, 1/e, 2010, Springer.
4. *IEEE Journals of Photonics Technology Letters, JLT, Sec. Topics in Quantum Electrons* etc.
5. Tools: Matlab ,Comsol Multiphysics(*https://www.istem.gov.in/rd-infrastructure-map/software-Through-istem*), Ansys Lumerical, OptiSysem.
6. Tools: Python, KLayout, SiEPIC tools, and pdk (*https://github.com/SiEPIC*)

2.3 Third Semester

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2.3.1 EC-CC-600 Dissertation-I.

Course Code	:	$EC - CC - 600$
Course Name	:	*Dissertation-I.*
Contact Hours per Week	:	*16(Twenty Four) Hours.*
Marks Distribution	:	*Sessional Works = 80, End Semester Examination =120.*
Questions to be Set	:	*N/A*
Questions to be Answered	:	*N/A.*
Duration of End Semester Examination	:	*N/A.*

The Project evaluation will be done based on the following components:

1. Problem Identification and Review of Related Literature
2. Proposal Writing and Presentation
3. Data Collection
4. Data Analysis, Interpretation and Discussion
5. Report Writing
6. Viva Voce

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2.3.2 EC-DSEC-60101 Analog IC Design.

Course Code	:	$EC - DSEC - 60101$
Course Name	:	*Analog IC Design.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: Learn the basic approach to design CMOS-based analog building blocks.

Objectives: On completion of this paper, students should be able to:

CO1: Learn various topologies of analog design blocks.

CO2: Complete design of CMOS-based OPAMP for desired specifications.

CO3: Understand approaches to design specialized circuit architectures for high-speed and low-power applications.

Unit I: Introduction to MOS and basic building blocks: Introduction to analog design, basic MOS device physics, MOS device models, short channel effects and device models, single-stage amplifiers, common source stage, source follower, common gate stage, cascode stage.

Unit II: CMOS amplifier design: Differential amplifiers (single-ended and differential operation), basic differential pair, common mode response, differential pair with MOS loads, Gilbert cell, passive and active current mirrors, basic current mirrors, cascode current mirrors, active current mirrors.

Unit III: Feedback amplifiers and comparators: Frequency response of amplifiers, stability and frequency compensation, comparators and their characterization, operational amplifiers, one-stage and two-stage op-amps, gain boosting, common-mode feedback, input range limitations, slew rate, power supply rejection, noise in op-amps.

Unit IV: Advanced analog circuit design: Stability and frequency compensation techniques, low-power and high-speed circuits, bandgap references, introduction to switched-capacitor circuits, nonlinearity and mismatch.

Text Books:

1. B. Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw-Hill, 2000.
2. Phillip E. Allen and Douglas R. Holberg, *CMOS Analog Circuit Design*, 3rd ed., Oxford University Press, 2011.
3. Randall L. Geiger, Phillip E. Allen and Noel Strader, *VLSI Design Techniques for Analog and Digital Circuits*, McGraw-Hill, 2010.
4. R. Jacob Baker, *CMOS Circuit Design, Layout, and Simulation*, 3/e, Wiley-IEEE Press, 2010.

Reference Books:

1. Yannis Tsividis and Colin McAndrew, *The MOS Transistor*, 3/e, Oxford University Press, 2013.
2. R. Jacob Baker, *CMOS Mixed-Signal Circuit Design*, 2/e, Wiley-IEEE Press, 2009.

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2.3.3 EC-DSEC-60102 Speech Processing.

Course Code	:	$EC - DSEC - 60102$
Course Name	:	*Speech Processing.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To obtain an overview of speech signal processing techniques with application to speaker recognition.

Objectives: On completion of this paper, students should be able to:

CO1: To understand the speech production system and its digital model.

CO2: To analyze speech signals using digital signal processing techniques.

CO3: To measure various parameters useful for speech recognition.

CO4: To investigate applications of speech processing for speaker recognition.

Unit I: Fundamentals of speech: Production and classification of speech sounds, acoustic phonetics, speech production mechanism and its digital models.

Unit II: Measurement of speech parameters: Feature extraction and digital representation of speech, distortion measurements, log spectral and cepstral distances, likelihood distortions.

Unit III: Speech recognition: Pattern comparison techniques, spectral distortion using warped frequency scale, dynamic time warping, introduction to deep learning-based methods.

Unit IV: Speaker recognition: Basics of speaker recognition, feature selection, hyperparameter optimization, building state-of-the-art speaker recognition systems.

Text Books:

1. D. Jurafsky and J. H. Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*, 2/e, 2014.
2. L. Rabiner and B. H. Juang, , *Fundamentals of Speech Recognition*, 2003.
3. T. F. Quatieri, *Discrete-Time Speech Signal Processing: Principles and Practice*, Pearson Education India, 2006.

Reference Books:

1. J. R. Deller Jr., *Discrete-Time Processing of Speech Signals*, 1993.
2. Rabiner, L. R., *Digital Processing of Speech Signals*, Pearson Education India, 1978.

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2.3.4 EC-DSEC-60201 Image Processing for Computer Vision.

Course Code	:	$EC - DSEC - 60201$
Course Name	:	*Image Processing for Computer Vision.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To get an in-depth understanding of various image processing algorithms with applications.

Objectives: On completion of this paper, students should be able to:

CO1: To understand transforms for image analysis.

CO2: To learn image restoration and segmentation.

CO3: To get an overview of image reconstruction from projections.

CO4: To understand applications to computer vision.

Unit I: Introduction to image transforms: Review of digital images, 2-D signals and systems, 2-D DFT, cosine and Hadamard transforms, transform operations, image smoothing and sharpening using frequency domain filters.

Unit II: Image restoration and segmentation: Image restoration techniques, noise models and filter types, geometric transforms, image segmentation, classification techniques.

Unit III: Image compression and reconstruction: Compression techniques and standards, image reconstruction from projections, back projection operator, projection theorem.

Unit IV: Image recognition and computer vision: Artificial neural networks for pattern classification, convolutional neural networks, motion estimation, object tracking.

Text Books:

1. A. K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989.
2. S. J. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012.
3. R. C. Gonzalez, *Digital Image Processing*, Pearson Education India, 2009.

Reference Books:

1. M. A. Joshi, *Digital Image Processing: An Algorithmic Approach*, PHI Learning, 2018.
2. R. Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2010.

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2.3.5 EC-DSEC-60202 Social Robotics.

Course Code	:	$EC - DSEC - 60202$
Course Name	:	*Social Robotics.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To provide an in-depth understanding of the design, development, and evaluation of social robots, focusing on human-robot interaction (HRI), cognitive and affective capabilities, and their applications in real-world societal contexts.

Objectives: On completion of this paper, students should be able to:

CO1: Analyze theoretical foundations, interaction paradigms, and technological challenges in social robotics and HRI.

CO2: Design socially interactive robotic systems integrating perception, cognition, communication, and adaptive behavior.

CO3: Evaluate social robot applications using experimental methods, user studies, and data-driven approaches.

CO4: Assess ethical, legal, and societal implications of deploying social robots in real-world environments.

Unit I: Foundations of Social Robotics and HRI: Introduction to social robotics; differences from traditional robotics; applications in healthcare, education, assistive systems, and service industries; fundamentals of human-robot interaction (HRI); embodiment and robot morphology; perception of robots by humans; multimodal interaction.

Unit II: Perception, Cognition, and Interaction: Social perception and sensing; emotion recognition and affective computing; socio-cognitive models; natural language processing for interaction; speech, gesture, and facial interaction; machine learning approaches for behavior adaptation.

Unit III: Design Methodologies and Evaluation: User-centered design and participatory design; experimental design in HRI studies; evaluation metrics and usability studies; case studies: autism spectrum disorder (ASD), intellectual disability (ID), elderly care, and rehabilitation; deployment challenges in real environments.

Unit IV: Ethics, Society, and Emerging Trends: Ethical, legal, and social implications (ELSI); trust, privacy, and safety in human-robot interaction; explainability and transparency; cultural and societal acceptance; emerging trends: AI-driven social robots, edge AI in robotics, collaborative robots, and future research directions.

Text Books:

1. Cynthia Breazeal, *Designing Sociable Robots*, MIT Press, 2004.
2. Christoph Bartneck et al., *Human-Robot Interaction: An Introduction*, Cambridge University Press, 2020.
3. Takayuki Kanda and Hiroshi Ishiguro, *Human-Robot Interaction in Social Robotics*, CRC Press, 2017.

Reference Books:

1. Raya Jones, *Personhood and Social Robotics: A Psychological Consideration*, Routledge, 2015.
2. Bruno Siciliano, and Oussama Khatib (Eds.), *Springer Handbook of Robotics*, Springer, 2016.
3. Kerstin Dautenhahn, *Socially Intelligent Robots: Dimensions of Human-Robot Interaction*, Philosophical Transactions of the Royal Society, Biological sciences 362, No. 1480, 2007.
4. Tony Belpaeme, James Kennedy, Aditi Ramachandran, Brian Scassellati, and Fumihide Tanaka, *Social robots for education: A review*, Science Robotics 3, No. 21, 2018.
5. Maja J. Matarić, *The Robotics Primer*, MIT Press, 2007.
6. Relevant IEEE/ACM Transactions on HRI and Robotics journals.

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2.3.6 EC-DSEC-60203 MIMO Wireless Communication.

Course Code	:	$EC - DSEC - 60203$
Course Name	:	*MIMO Wireless Communication.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To introduce advanced wireless communication techniques for next generation communications.

Objectives: On completion of this course, students should be able to:

CO1: Understand the MIMO wireless communications.

CO2: Familiarize with different wireless transmission techniques.

CO3: Familiarize with different receiving techniques.

CO4: Introduce the latest wireless communication trends.

Unit I: Fundamentals of MIMO Systems: Introduction to MIMO systems, classical and generalized fading distributions, the wireless channel, applications of MIMO systems, analytical MIMO channel model.

Unit II: MIMO Detection Techniques: Introduction to MIMO detection, space-time block and trellis codes, linear sub-optimal detectors, advanced MIMO detection techniques.

Unit III: Antenna Selection, Spatial Modulation, and Multicarrier Transmission: Antenna selection and spatial modulation, multicarrier transmission, transmit antenna selection, performance analysis with antenna selection.

Unit IV: Advanced MIMO Techniques and Large-Scale MIMO Systems: Advanced topics in MIMO wireless communications, MIMO-based cooperative communication, large-scale MIMO systems.

Text Books:

1. T. S. Rappaport, *Wireless Communication: Principles and Practice*, Prentice-Hall of India, 2007.
2. Andreas Molisch, *Wireless Communications*, Wiley-IEEE Press, 2007.
3. Simon Haykin, *Communication Systems*, Wiley India, 2006.
4. Arogyaswami Paulraj, *Introduction to Space-Time Wireless Communications*, Cambridge University Press, 2006.

Reference Books:

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2005.
2. David Tse and Pramod Viswanath, *Fundamentals of Wireless Communications*, Cambridge University Press, 2005.
3. Mischa Schwartz, *Mobile Wireless Communications*, Cambridge University Press, 2005.
4. J. G. Proakis and M. Salehi, *Digital Communications*, 5/e, McGraw-Hill International Edition, 2008.

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3	-	1	-	0	=	4

2.3.7 EC-DSEC-60301 Spoken Language Identification Techniques.

Course Code	:	$EC - DSEC - 60301$
Course Name	:	*Spoken Language Identification Techniques.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: To get an in-depth understanding of various spoken language identification techniques.

Objectives: On completion of this paper, students should be able to:

CO1: To understand the structures of spoken languages.

CO2: To analyze speech signals for language recognition.

CO3: To understand various pattern recognition techniques.

CO4: To investigate language models and use them for spoken language recognition.

Unit I: Spoken language structure: Sound production and human speech system, phonetics and phonology, syllables and words, syntax and semantics.

Unit II: Speech processing for language recognition: Short-time Fourier transform, acoustic model of speech production, cepstral processing, perceptually motivated representations (MFCC, PLP).

Unit III: Pattern recognition basics: Bayes decision theory, construction of classifiers, supervised and unsupervised estimation methods.

Unit IV: Language and statistical models: Acoustic and language models, introduction to hidden Markov models (HMM), isolated word recognition, shallow and deep features for language recognition.

Text Books:

1. D. Jurafsky and J. H. Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*, 2/e, 2014.
2. L. R. Rabiner and B. H. Juang, *Fundamentals of Speech Recognition*, 2003.
3. X. Huang, A. Acero, H. W. Hon and R. Reddy, *Spoken Language Processing: A Guide to Theory, Algorithm, and System Development*, Prentice Hall PTR, 2001.

Reference Books:

1. J. R. Deller Jr., *Discrete-Time Processing of Speech Signals*, 1993.
2. L. R. Rabiner, *Digital Processing of Speech Signals*, Pearson Education India, 1978.
3. T. F. Quatieri, *Discrete-Time Speech Signal Processing: Principles and Practice*, Pearson Education India, 2006.

L	-	T	-	P		
3	-	1	-	0	=	4

2.3.8 EC-DSEC-60302 Millimeter-wave and Terahertz Techniques.

Course Code	:	$EC - DSEC - 60302$
Course Name	:	*Millimeter-wave and Terahertz Techniques.*
Contact Hours per Week	:	*4(Four) Hours.*
Marks Distribution	:	*Sessional Works = 40, End Semester Examination = 60.*
Questions to be Set	:	*Eight.*
Questions to be Answered	:	*Any 5(Five).*
Duration of End Semester Examination	:	*3(Three) Hours.*

Aim: The aim of the course is to provide students with a wide introduction to millimeter and sub-millimeter (Terahertz) technology for industrial, radio astronomy, environmental science and other applications.

Objectives: On completion of this paper, students should be able to:

CO1: Understand the characteristics of mm-wave and THz communication technologies.

CO2: Explain and model different mm-wave semiconductor devices.

CO3: Design and develop mm-wave and THz communication devices and circuits.

Unit I: mm-Wave and THz Channel Characteristics and Propagation: mm-Wave and THz wave characteristics, regulation, propagation at mm-waves, THz propagation and channel modeling.

Unit II: Advanced Semiconductor Devices for High-Frequency Systems: Transient and AC behavior of P-N junctions; PIN diode, varactor diode and applications; Schottky effect, Schottky barrier diode and applications; heterojunctions; high electron mobility transistor (HEMT).

Unit III: Integrated mm-Wave/THz Circuits and Packaging Technologies: mm-wave and THz integrated passive components; circuits and interconnects; millimeter-wave design considerations; mm-wave and THz component packaging.

Unit IV: Beamforming, Massive MIMO, and Advanced Antenna Technologies: Advanced beam steering technology; advanced beamforming technology; advanced antenna technologies; millimeter-wave MIMO; spatial diversity of antenna arrays.

Text Books:

1. Duixian Liu, Brian Gaucher, Ulrich Pfeiffer, and Janusz Grzyb, *Advanced Millimeter-Wave Technologies: Antennas, Packaging and Circuits*, John Wiley & Sons Ltd., United Kingdom, 2009.
2. Kao-Cheng Huang and Zhaocheng Wang, *Millimeter Wave Communication Systems*, John Wiley & Sons Inc., Hoboken, New Jersey 2011.
3. S. Ahmad, *Microwave and Millimeter Wave Semiconductor Materials Technology*, Tata McGraw Hill.
4. Thomas Kurner, Daniel M. Mittleman and Tadao Nagatsuma, THz Communications. Springer Series in Optical Sciences, vol 234. Springer, Cham.

Reference Books:

1. D. M. Pozar, *Microwave Engineering*, 4/e, John Wiley, 2011.
2. Peter A. Rizzi, *Microwave Engineering: Passive Circuits*, 1/e, Prentice Hall, 1987.

2.4 Fourth Semester

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0	-	0	-	32	=	16

2.4.1 EC-CC-604 Dissertation-II.

Course Code	:	$EC - CC - 604$
Course Name	:	*Dissertation-II.*
Contact Hours per Week	:	*32(Thirty Two) Hours.*
Marks Distribution	:	*Sessional Works = 160, End Semester Examination =240.*
Questions to be Set	:	*N/A*
Questions to be Answered	:	*N/A.*
Duration of End Semester Examination	:	*N/A.*

Aim: The aim of Dissertation work for M. Tech (ECE) is to obtain an understanding of how to define, plan, undertake and report on an open-ended piece of supervised research or design work.

2.4.1.1 Introduction

The aim of Dissertation work for M. Tech (ECE) is to obtain an understanding of how to define, plan, undertake, and report on an open-ended piece of supervised research or design work. Students will discuss the Dissertation topic with the supervisor(s) and generate a suitable Dissertation research plan with proposed outcomes. They will then conduct a literature survey and background research.
Students are required to write a detailed report on a major research or design project. Some projects will be experimental in nature; others may involve computer-based simulation, feasibility studies or the design, construction, and testing of equipment. In the ordinary course of events, some or all of the theoretical, developmental, and experimental aspects of design or research work will be covered in this unit of study. These aspects may be either directed by the supervisor or be of an original nature, but in any event, the student is responsible for the execution of their practical work and the general layout and content of the Dissertation document. During this unit of study, students will learn how to examine published and experimental data, set objectives, organize a work program, and analyze results. They will also evaluate these results in relation to existing knowledge.
The Dissertation will be adjudicated on the extent and quality of the student's original work, particularly how critical, perceptive, and constructive the student has been in assessing their work and that of others. Students will also be required to present the results of their findings to their peers and supervisors in seminars.

2.4.1.2 Learning Outcomes

Learning outcomes are the key abilities and knowledge that will be assessed in this Dissertation. Outcomes are listed according to the Dissertation goals that they support.

Engineering/IT Specialization (Level 5)

1. Development of a higher level of research skills and expertise in specific area(s).
2. Implementation of the research plan.
3. Ability to plan and undertake a major research or design project.
4. Ability to design and conduct experiments or tests and to analyze and interpret data.
5. Ability to work independently on a substantial project.

Information Seeking (Level 4)

1. Literature survey and in-depth review.

Communication (Level 4)

1. Preparation and submission of a dissertation detailing the context of the problem, relevant background research and results of the investigation.
2. Development of seminar presentation skills.

Professional Conduct (Level 4)

1. Understanding of research ethics, intellectual property, and commercialization potential.

2.4.1.3 Assessment Tasks

Assessment Summary

Sl. No.	Assessment Name	Weight	Tentative Due	Learning Outcomes
1	Progress Report	5% + 5% = 10%	March & June	2, 6
2	Presentation/Seminar	10 + 10 + 10 = 30%	March, April and May	3, 6, 8
3	Thesis	60%	June	1, 2, 3, 4, 5, 6, 7

2.4.1.4 Assessment Description

Progress Report: A progress report should include a literature review, research plan, and intermediate outcomes in a format developed by the Department of ECE, as prescribed in the departmental academic calendar.

Presentation/Seminar: Seminar presentations will be given in Semester 4, consisting of about a 20-minute presentation followed by 5 minutes of questions and answers, as per the academic timetable.

Thesis/Dissertation: A research dissertation will be submitted covering (a) Literature review, (b) Methods and materials, (c) Results, (d) Discussion, and (e) Conclusion, along with references and appendices.

2.4.1.5 Attributes Developed

Sl. No.	Attribute	Method
1	Engineering Specialization (Level 5)	Students are expected to demonstrate initiative and ingenuity in research, critical analysis of material, thoroughness of design, and innovative interpretation of evidence.
2	Information Seeking (Level 4)	Results and conclusions should be presented in the appropriate literature context. Students are expected to efficiently seek, evaluate, and use relevant information sources.
3	Communication (Level 4)	Written communication is developed through Progress Reports and Thesis writing. Seminar presentations enhance oral communication and presentation skills.
4	Professional Conduct (Level 4)	Emphasis is placed on valuing engineering judgment, understanding ethical, social, and professional implications of work.

Text Books:

1. Mark Breach, *Dissertation Writing for Engineers and Scientists*, Prentice Hall (UK), Student Edition, 2009.
2. Derek Swetnam, *Writing Your Dissertation*, How To Books, 3/e, 2000.
3. Evelyn Hunt Ogden, *Complete Your Dissertation or Thesis in Two Semesters or Less*, Rowman & Littlefield Publishers, 3/e, 2006.
4. Carol M. Roberts, *The Dissertation Journey*, Corwin, 2/e, 2010.

Reference Books:

1. Tonette S. Rocco and Tim Hatcher, *The Handbook of Scholarly Writing and Publishing*, Jossey-Bass, 2011.
2. Lawrence A. Machi and Brenda T. McEvoy, *The Literature Review: Six Steps to Success*, Corwin, 2/e, 2012.
3. Emily Alana James and Tracesea H. Slater, *Writing Your Doctoral Dissertation or Faster: A Proven Map to Success*, SAGE Publications, 2013.