



SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE

(An Autonomous Institution)

Puducherry - 605 107

*5th UG - Board of Studies Meeting in the department of
Electronics and Communication Engineering*

for the Programme
B.Tech – Electronics and Communication Engineering

Venue

Seminar Hall, Department of ECE
Sri Manakula Vinayagar Engineering College
Madagadipet, Puducherry – 605 107

Date & Time

17-09-2022 & 10.30 am

BOARD OF STUDIES MEETING

The Fifth Board of Studies meeting for B.Tech. Electronics and Communication Engineering was held on 17th September 2022 at 10:30 am in the Seminar Hall, Department of ECE, Sri Manakula Vinayagar Engineering College, with the Head of the Department in the Chair.

The following members were present for the BoS meeting in the venue.

Sl. No	Name of the Member	Designation
1	Dr. P. Raja Professor and Head, Department of ECE	Chairman
2	Mr. C. Gnanavel General Manager, Production and Technology, Lenovo India Ltd., Puducherry	Industry Member
3	Dr. V. Bharathi, Specialization: Wireless Communication	Member
4	Dr. R. Ramya, Professor/ ECE Specialization: ECE	Member
5	Dr. J. Pradeep, Associate Professor / ECE Specialization: Image Processing	Member
6	Dr. R. Kurinjimalar, Associate Professor / ECE Specialization: Mobile Satellite Communication	Member
7	Dr.N.Jothy Associate Professor / ECE Specialization: Wireless Communication	Member

Department of ECE – Fifth BoS Meeting

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8	Prof. R. Illayaraja Assistant Professor Specialization: VLSI Design	Member
9	Prof. Egalite Francis , Assistant Professor Specialization: Mathematics	Member
10	Prof. K. Oudayakumar , Associate Professor Specialization: Physics	Member
11	Dr. S. Deepa , Professor Specialization: Chemistry	Member
12	Dr. D. Jaichithra , Professor and Head Specialization: English	Member
13	Mr. G. Dharanidharan Associated Functional Consultant, Birlasoft Limited, Old Mahabalipuram Road, Chennai – 600096	Alumni Member

The following members were present in the online platform

Sl. No	Name of the Member	Designation
1	Dr. Gerardine Immaculate Mary Professor, Department of Embedded Systems, Vellore Institute of Technology (VIT), Vellore, Tamil Nadu, India	Expert Member (University Nominee)
2	Dr. N. Venkateswaran Professor, Department of ECE, SSN - College of Engineering, Kalavakkam, Tamil Nadu, India	Expert Member (Academic Council Nominee)
3	Dr. V. R. Vijayakumar Associate Professor & Head, Department of ECE, Anna University, Regional Campus, Coimbatore	Expert Member (Academic Council Nominee)

AGENDA OF THE MEETING

BoS /2022/UG/ECE 5.1

To review and confirm the minutes of the Fourth BoS meeting held on 26th February 2022

BoS /2022/UG/ECE 5.2

To consider and approve syllabi VIII semester of B.Tech. ECE is to be offered under Regulations 2020 for the students admitted in the academic year 2020 - 21

BoS /2022/UG/ECE 5.3

To ratify the professional and open electives chosen by VII semester students admitted for the academic year 2019–20 in accordance with Regulations 2019

BoS /2022/UG/ECE 5.4

Any other item with the permission of the chair

MINUTES OF THE MEETING

Dr. P. Raja, Chairman, BoS opened the meeting with a warm welcome and thanked all the members for accepting the 5th BoS meeting Invitation for the B.Tech – Electronics and Communication Engineering program. The Chairman proceeded to the meeting subsequently and discussed the agenda items.

BoS / 2022 / UG / ECE 5.1

To review and confirm the fourth BoS meeting minutes held on 26th February 2022

The Fourth BoS Meeting for B.Tech.- Electronics and Communication Engineering under Regulations 2020 and Regulations 2019 was held on 26th February 2022. The Members had reviewed the Minutes of fourth BoS Meeting, and it was approved

Minutes are Reviewed and Confirmed

BoS /2022 / UG / ECE 5.2

To consider and approve syllabi VIII semester of B.Tech. ECE is to be offered under Regulations 2020 for the students admitted in the academic year 2020 - 21

Members have discussed the syllabi of semesters VIII of B.Tech- Electronics and Communication Engineering under Regulation 2020, and the suggestions were provided course wise accordingly

Course-wise suggestions for the semester- VIII under Regulations 2020

1. Cyber Physical System(U20ECT818)

Members recommended changing the course title to "Cyber Physical System and Security" instead of the course title "Cyber Physical System". Related security concepts to be included in the course syllabus.

Suggestions to Professional Elective V (U20ECE8XX)

1. High Speed Electronics (U20ECE821)

Members suggested doing slight modifications in the syllabus since the contents are fully based on semiconductors and also informed to provide practical applications related to the courses

2. Machine Learning for Wireless Communication (U20ECE822)

Members discussed the addition of machine learning algorithms. Members suggested changing the title as Machine Learning and its Applications.

3. Virtual and Augmented Reality(U20ECE823)

Members recommended to change the title of the paper as "Augmentation and Virtual Reality" and need to include Augmentation in the content of the syllabus.

Department of ECE – Fifth BoS Meeting

Suggestions to Professional Elective VI (U20ECT8XX)

1.VLSI for Communication Systems (U20ECE826)

Members approved the syllabus in VLSI for Wireless Communication in Unit- IV, and the subtopics need to be included.

2.5G Wireless Communication Systems (U20ECE827)

Members Propounded to include the channel model in Unit-II.

3. Biomedical Electronics (U20ECE828)

Members proposed to include Unit III as Calibration of Medical Equipment

4. Advanced Digital Image Processing (U20ECE829)

Members suggested replacing unit –IV with Video Analytics

All the suggestions will be considered and will be updated in the respective courses. The details are given in **Annexure - I**

Approved with Minor corrections and Recommended to Academic Council

BoS /2022 / UG / ECE 5.3

To ratify the professional and open electives chosen by VII semester students admitted for the academic year 2019–20 by Regulations 2019.

As per the Regulations, each student shall choose one professional elective in semester VII in consultation with the Class Advisor, Programme Academic Coordinator and the HoD. The opted elective course will be offered only if the number of students opted for that course is not less than 30. However, if the student's enrollment in a class is less than 30, the head of the department will decide on the elective course.

List of Professional Elective IV (U19ECE7X)

1. CAD for VLSI Circuits (U19ECE71)
2. Satellite Communication (U19ECE72)
3. Fuzzy Logic and Neural Network (U19ECE73)
4. Wireless Sensor Networks (U19ECE75)

List of Open Elective

1. Hybrid and Electrical Vehicle (U19EEO75)
2. Data Science using python (U19CCO75)
3. Artificial Intelligence Applications (U19ADO74)
4. Industrial Automation (U19ICO75)

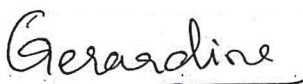
The details of students offered the electives are given in **Annexure – II**.

- Chairman asked about the new curriculum in line with NEP-2020. Members suggested providing more inter-disciplinary courses
- The members proposed to consider 40 percentage of internal members and 60 percentage of external members for evaluation
- The expert members suggested including theory and laboratory Integrated courses in the syllabus
- The members recommended to include more computer-oriented courses in the syllabus, and the overall credit should be a maximum of 160
- Syllabus formation for the next academic year will be meeting the industrial requirements, which was a well-defined syllabus and future technologies can be added

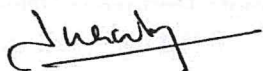
Dr. P. Raja, Chairman – BoS and Head of Department, Electronics and Communication Engineering, concluded the meeting at 12.30 pm with the vote of thanks.



Dr. P. RAJA
Board Chairman - ECE



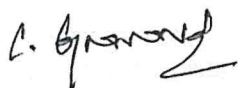
Dr. GERARDINE IMMACULATE MARY
Professor, Department of Embedded Systems,
Vellore Institute of Technology (VIT), Vellore
(Expert Member - University Nominee)



Dr. N. VENKATESWARAN
Professor, Department of ECE,
SSN College of Engineering, Kalavakkam
(Expert Member – AC Nominee)



Dr. V. R. VIJAYAKUMAR
Associate Professor & Head, Department of
ECE, Anna University, Regional Campus,
Coimbatore
(Expert Member – AC Nominee)



Mr. C. GNANAVEL

Manager, Production and Technology,
Lenovo India Ltd., Puducherry
(Industry Member)



Mr. DHARANIDHARAN. G

Associated Functional Consultant,
Birlasoft Limited, Chennai
(Alumni Member)



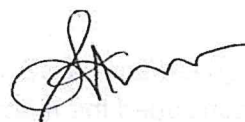
Dr. R. RAMYA
Professor/ ECE
(Member)



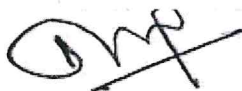
Dr. V. BHARATHI
Professor / ECE
(Member)



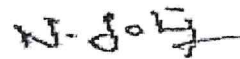
Dr. J. PRADEEP
Associate Professor / ECE
(Member)



Dr. R. KURINJIMALAR
Associate Professor / ECE
(Member)



Prof. R. ILAIYARAJA,
Assistant Professor / ECE
(Member)



Dr. N. JOTHY
Associate Professor / ECE
(Member)



Dr. D. JAICHITHRA
Professor / English
(Member)



Prof. K. OUDAYAKUMAR
Associate Professor / Physics
(Member)

ANNEXURE - I

Course Objectives:

- To understand the overview of cyber-physical system and its different application domains
- To know the hardware and software platforms of cyber-physical system
- To gain knowledge about the synchronous and asynchronous models of CPS
- To learn about the cyber-physical system safety and security.
- To provide adequate knowledge about security in operating system and network.

Course Outcomes:

After completion of the course, the students will be able to

- CO1 - Able to have understanding of the core principle behind the cyber-physical system (K2)
 CO2 - Gain an overview of the hardware and software platform of cyber-physical system (K2)
 CO3 - Identify and analyse the synchronous and asynchronous model of cyber-physical system (K3)
 CO4 - Describe the cyber-physical system safety and security (K3)
 CO5 - Acquire clear knowledge about security in operating system and network(K4)

UNIT-I INTRODUCTION TO CYBER-PHYSICAL SYSTEM**(9 Hrs)**

Introduction to Cyber-Physical Systems (CPS), Basic principles of design and validation of CPS, CPS requirements, Challenges in cyber-physical system, Industry standards, Key features of cyber-physical systems, Application of CPS- industry 4.0, AutoSAR, IIOT implications, Building automation, Medical CPS.

UNIT-II CPS HARDWARE AND SOFTWARE PLATFORM**(9 Hrs)**

CPS hardware platforms: Processors-Types of processor, Parallelism, Sensors- Model of sensor, Sensor types, Actuators, Memory architectures-Memory technologies, Memory hierarchy, Memory model, CPS network – Wireless Hart, CAN, Automotive Ethernet, CPS software stack – RTOS, Scheduling real-time control tasks.

UNIT-III SYNCHRONOUS AND ASYNCHRONOUS MODEL**(9Hrs)**

Synchronous model: Reactive components, Properties of components, Composing components, synchronous design, Synchronous circuits, Cruise control system, Synchronous networks, Asynchronous model: Asynchronous processes- Asynchronous design primitives, Coordination protocols- Leader election, Reliable transmission, Wait-free consensus, Real-time scheduling: Scheduling concepts, EDF scheduling, Fixed – Priority scheduling.

UNIT-IV CYBER PHYSICAL SYSTEM SAFETY & SECURITY**(9Hrs)**

CPS Safety specification, verifying invariants, Enumerative Search, Symbolic search, Cyber Security requirement, Attack models, secure task mapping and partitioning, state estimation for attack detection, Advanced Techniques –System theoretic approaches, automotive case study vehicle ABS hacking, Power distribution case study, attacks on smart grids.

UNIT V SECURITY IN OPERATING SYSTEM & NETWORK**(9Hrs)**

Security in Operating Systems - Security in the Design of Operating Systems -Rootkit - Network security attack- Threats to Network Communications - Wireless Network Security - Denial of Service - Distributed Denial-of-Service.

Text Books

1. E.A.Lee & S.A.Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", PHI Learning Private Limited, 4th Edition, 2019.
2. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press, 2015.
3. Raj Rajkumar, "Cyber-Physical Systems", Elsevier, 2nd Edition, 2015.
4. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition , Pearson Education , 2015

Reference Books

1. Houbing Song, Danda.B. Rawat & Sabina Jeschke, "Cyber physical system, Foundations, Principles and Application", Todd Green, Elsevier, 2017.
2. Edward D Lamie, "Computing Fundamentals of Cyber Physical Systems", Newnes Elsevier Publication, 2nd Edition, 2011.
3. Andrea Bondavalli, Sara Bouchnak & Hermann Kopetz, "Cyber-physical systems of systems: Foundations-A conceptual model and some derivations", Springer Nature, 2016.
4. Andre Platzer, "Logical Foundations of Cyber-Physical System", Springer, 2018.
5. Gaddadevara Matt Siddesh, Ganesh Chandra Deka, Krishnaraja nagar Gopalalyengar Srinivasa, Lait Mogan Patnaik, "Cyber-Physical systems-A Computational Perspective", CRC Press, 2015.

Web Resources

1. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs24/>
2. <https://www.nist.gov/el/cyber-physical-systems>
3. <https://www.sciencedirect.com/topics/engineering/cyber-physical-systems>
4. <https://www.coursera.org/learn/cyber-physical-systems-1>
5. <https://www.elsevier.com/books/cyber-physical-systems/song/978-0-12-803801-7>

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-
2	3	1	-	-	-	-	-	-	-	-	-	-	2	1	-
3	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
4	3	2	2	2	1	-	-	-	-	-	-	-	3	2	1
5	3	2	2	2	1	1	-	-	-	-	-	-	3	2	1

Correlation Level: 1-Low, 2-Medium, 3- High

Course Objectives

- To give exposure on the band diagram of compound Semiconductor Material.
- To understand the characteristics and electrical properties of hetero-junction devices
- To introduce new high speed transistors like MESFETs, HBTs, HEMTs
- To understand the principle of high speed transistors
- To gain knowledge about devices used in high frequency applications

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand the fundamentals of compound Semiconductor heterostructures. (K2)

CO2 – Explain about electrical properties of heterostructures. (K2)

CO3 – Understand the operation of MESFETS (K2)

CO4 – Discuss the principle and operation of HEMT (K2)

CO5 – Describe the working of HBTs and discontinuities in heterostructures. (K2)

UNIT - I HETEROSTRUCTURE FUNDAMENTALS**(9 Hrs)**

Energy Band Alignment – Strained Layer Structures – Band Energies in strained ternary and Quaternary Alloys – Construction of Heterostructure Band Diagrams

UNIT- II ELECTRICAL PROPERTIES SEMICONDUCTOR HETERO STRUCTURES**(9 Hrs)**

Abrupt heterojunction Under equilibrium – p – N Heterojunction under bias – Quantum well Heterostructures – Superlattices and minibands – Heterostructure in Electric Fields

UNIT - III METAL SEMICONDUCTOR FIELD EFFECT TRANSISTOR**(9 Hrs)**

Basic principle of operation – Current – Voltage Characteristics – Trans conductance and equivalent circuit of MESFET – High speed figure of merit – MESFET fabrication and Performance

UNIT - IV HIGH ELECTRON MOBILITY TRANSISTORS**(9 Hrs)**

High Electron Mobility Transistor – Basics – Operation properties of HEMT – Optimal design of HEMT – GaN Based HEMT structures

UNIT - V HETRO JUNCTION BIPOLAR TRANSISTORS**(9 Hrs)**

Basic theory of HBT – Band Discontinuity of Heterostructures – High frequency operation of HBT – Basics of HBT processing

Textbooks

- 1 Keh Yung Cheng, " III-V Compound Semiconductors and Devices – An Introduction to Fundamentals, Springer
- 2 M. S. Tyagi, "Introduction to Semiconductor Materials and Devices", John Wiley and Sons, 2008.
- 3 M. J. Madou, Fundamentals of Microfabrication, 2nd Edition, CRC Press, 2011.
- 4 P. Bhattacharya, Semiconductor Optoelectronics Devices, 2nd Edition, PHI, 2009.
- 5 Nandita Das Gupta and Amitava Das Gupta, "Semiconductor Devices: Modeling and Technology", Prentice Hall of India, 2012.

Reference Books

- 1 S. M. Sze, "Physics of Semiconductor Devices", 3rd edition, John Wiley and Sons, 2007.
- 2 J. Singh, "Semiconductor Devices: Basic Principles", John Wiley and Sons, 2007.
- 3 J. P. McKelvey, Introduction to Solid State and Semiconductor Physics, Harper and Row and John Weather Hill.
- 4 Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons, 1990.
- 5 Donald A Neamen, Semiconductor Physics and Devices: Basic Principles, McGraw-Hill (1997) ISBN 0-256-24214-3

Web Resources

- 1 <https://nptel.ac.in/courses/117104071/>
- 2 <https://cosmolearning.org/courses/high-speed-devices-circuits/>
- 3 <https://www.docsity.com/en/lecture-notes/subjects/high-speed-electron-devices/>
- 4 <https://www.researchgate.net/journal/International-Journal-of-High-Speed-Electronics-and-Systems-0129-1564>
- 5 <https://ieeexplore.ieee.org/document/6647520>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	1	-	-	-	-	-	-	-	2	2	-	-
2	2	1	2	1	-	-	-	-	-	-	-	2	2	-	-
3	2	1	2	1	-	-	-	-	-	-	-	2	2	-	-
4	2	2	2	1	-	-	-	-	-	-	-	2	2	-	-
5	2	2	1	1	-	-	-	-	-	-	-	2	2	-	-

Correlation Level: 1-Low, 2-Medium, 3-High



Course Objectives

- Understand the principles of machine learning and apply the fundamental principles Data acquisition, pre-processing
- Apply machine learning principles algorithms based on supervised learning
- Understand optimization and dimensionality reduction using unsupervised learning
- To learn neural and deep neural networks for parallel processing
- To develop intelligent applications by applying the principles of machine learning

Course Outcomes

After completion of the course, the students will be able to

CO1 – Know the basic principles of machine learning **(K2)**

CO2 – Understand supervised learning algorithms and its basic classifications **(K2)**

CO3 – Optimize the performance using clustering algorithms **(K3)**

CO4 - Compare neural and deep neural networks for parallel processing **(K3)**

CO5 – Develop applications based on the concepts of machine learning **(K4)**

UNIT - I INTRODUCTION**(9 Hrs)**

Data acquisition, pre-processing, feature extraction and processing, feature ranking/selection, feature reduction, model learning, evaluation, deployment. Matrix algebra Feature Scaling, Learning Rate, Normal Equation, Features and Polynomial Regression, Logistic Regression-classification, hypothesis representation, decision boundary, cost function, optimization, multiclass classification.

UNIT - II SUPERVISED LEARNING**(9Hrs)**

Machine Learning Algorithms - KNN, SVM, Random Forest. Decision trees, Inductive bias, Classification, Regression, Perceptron, Tree learning algorithms. Model Selection and Generalization. Dimensions of a Supervised Machine Learning Algorithm

UNIT - III UNSUPERVISED LEARNING**(9Hrs)**

Introduction, k-means algorithm, optimization, random initialization, clustering. Dimensionality Reduction: Data compression, visualization, principal component analysis algorithm, reconstruction from compressed representation.

UNIT - IV NEURAL NETWORKS**(9Hrs)**

Artificial neurons, Neural Networks as a Paradigm for Parallel Processing. The Perceptron Gradients and back propagation, Gradient decent, Convolution neural networks: continuous convolution, discrete convolution, pooling. Recurrent neural networks. Deep neural networks.

UNIT - V APPLICATIONS**(9Hrs)**

Development of an application of machine learning; for example, Optical Character Recognition, Email spam identification, etc Machine Learning for communication: signal processing, adaptive filtering, modulation, spectrum sensing.

Text Books

1. Ethem Alpaydin, "Introduction to Machine Learning", 3e, MIT Press, 2014
2. Kevin P. Murphy, Machine Learning A probabilistic Perspective, MIT press, 2012
3. Machine Learning and Deep Learning Techniques in Wireless and Mobile Networking Systems (Big Data for Industry 4.0) by by K. Suganthi, R. Karthik, G. Rajesh, CRC Press; 1st edition, 2021.

Reference Books

- 1 Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006
- 2 T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st edition, 2001.
- 3 Luo, Fa-Long, ed. "Machine learning for future wireless communications." (2020).
- 4 Machine Learning and Cognitive Computing for Mobile Communications and Wireless Networks by Krishna Kant Singh, Akansha Singh, Wiley-Scrivener; 1st edition, 2020.
- 5 Applications of Machine Learning in Wireless Communications (Telecommunications) by Ruisi He and Zhiguo Ding, Institution of Engineering and Technology, 2019.

Web Resources

1. https://onlinecourses.nptel.ac.in/noc16_cs18/
2. <http://freevideolectures.com/Course/2257/Machine-Learning> Online courses: 1 2
3. <https://www.coursera.org/learn/machine-learning> <https://www.edx.org/course/machine-learning-data-science-analyticscolumbia-ds102x-0#>
4. <http://scikit-learn.org/stable/modules/clustering.html>
5. <https://towardsdatascience.com/k-means-clustering-algorithm-applications-evaluation-methods-and-drawbacks-aa03e644b48a>

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
2	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
3	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
4	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
5	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1

Correlation Level: 1-Low, 2-Medium, 3-High

Course Objectives

- To learn basic virtual Reality systems functions(operations)
- To design Virtual Reality considerations.
- To give knowledge of virtual environment hardware and software in virtual Reality applications
- To identify the concept of Augmented reality systems with its applications.
- To describe the Projector-based illumination and augmentation

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basic functioning of virtual Reality systems. **(K2)**

CO2 - Visualize the concepts of Geometric modelling and Geometrical Transformations. **(K2)**

CO3 - Learn Animated Virtual Environment, types of Hardware's and software's in virtual Reality systems **(K2)**

CO4 - Infer concept of Augmented reality systems with its applications. **(K2)**

CO5 - Describe the Projector-based illumination and augmentation with future displays. **(K2)**

UNIT - I INTRODUCTION**(9Hrs)**

Virtual Reality & Virtual Environment: Introduction – Computer graphics – Real time computer graphics – Flight Simulation – Virtual environments –requirement – benefits of virtual reality- 3D Computer Graphics : Introduction – The Virtual world space – positioning the virtual observer – the perspective projection – Human vision – stereo perspective projection – 3D clipping – Color theory – Simple 3D modeling – Illumination models – Reflection models – Shading algorithms.

UNIT - II GEOMETRIC MODELING GEOMETRICAL TRANSFORMATIONS**(9Hrs)**

Geometric Modeling: Introduction – From 2D to 3D – 3D space curves – 3D boundary representation - Geometrical Transformations: Introduction – Frames of reference – Modeling transformations – Instances – Picking – Flying – Scaling the VE – Collision detection - A Generic VR system: Introduction – The virtual environment- the Computer environment- VR Technology – Model of interaction- VR System.

UNIT – III VIRTUAL ENVIRONMENT**(9Hrs)**

Animating the Virtual Environment: Introduction – The dynamics of numbers – Linear and Non-linear interpolation - The animation of objects – linear and non-linear translation - shape & object in between – freeform deformation – particle system- Physical Simulation : Introduction – Objects falling in a graphical field –Rotating wheels – Elastic collisions – projectiles – simple pendulum – springs – Flight dynamics of an aircraft. VR Hardware & Software- Modelling virtual world –Physical simulation- VR toolkits – Introduction to VRML

UNIT – IV AUGMENTED REALITY**(9Hrs)**

Augmented Reality- Spatial Augmented Reality - Fundamentals: From Photons to Pixels - Augmented Reality Displays - Geometric Projection Concepts – Geometric Model - Rendering Framework - Calibration Goals - Display Environments and Applications.

UNIT – V PROJECTOR-BASED ILLUMINATION AND AUGMENTATION**(9Hrs)**

Image-Based Illumination: Changing Surface Appearance - Creating Consistent Occlusion - Creating Consistent Illumination - Augmenting Optical Holograms - Augmenting Flat and Textured Surfaces - Augmenting Geometrically Non-Trivial Textured Surfaces - Spatial AR Displays -Augmented Paintings- Future Displays and Supporting Elements

Textbooks

1. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
2. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Inter science, India, 2003.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005
4. M. LaValle, "Virtual Reality, Steven", Cambridge University Press, 2016

Reference Books

- 1 Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
- 2 John Vince, "Virtual Reality Systems", Addison Wesley, 2012.
- 3 William R Sherman and Alan B Craig, "Understanding Virtual Reality: Interface, Application and Design (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002.
- 4 Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005

Web Resources

1. <https://digitaldefynd.com/best-augmented-reality-courses/>
2. <https://www.edx.org/learn/augmented-reality>
3. <https://www.classcentral.com/course/augmented-reality-virtual-reality-mixed--10508>
4. <https://nptel.ac.in/courses/106/106/106106138/>
5. <https://www.coursera.org/learn/introduction-virtual-reality>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
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1	1	1	2	-	-	-	-	-	-	-	-	-	3	-	3
2	1	1	2	-	-	-	-	-	-	-	-	-	3	-	3
3	1	1	2	-	1	-	-	-	-	-	-	-	3	-	3
4	1	1	2	-	1	-	-	-	-	-	-	-	3	-	3
5	1	1	1	-	2	-	-	-	-	-	-	-	3	-	3

Correlation Level: 1-Low, 2-Medium, 3-High

Course Objectives

- To study the design concepts of low noise amplifiers.
- To learn various types of mixers designed for wireless communication.
- To design PLL and VCO.
- To acquire knowledge about various sub systems in wireless communication.
- To understand the concepts of CDMA in wireless communication.

Course Outcomes

After completion of the course, the students will be able to

- CO1** - Analyse the design concepts of low noise amplifiers. **(K4)**
CO2 - Differentiate various types of mixers designed for wireless Communication. **(K4)**
CO3 - Able to design PLL and VCO. **(K3)**
CO4 - Recognize various sub systems in wireless communication. **(K3)**
CO5 - Understand the concepts of CDMA in wireless communication. **(K2)**

UNIT - I COMPONENTS AND DEVICES**(9 Hrs)**

Introduction of wireless system - Integrated inductors, resistors, MOSFET and BJT Amplifier Design: Low Noise Amplifier Design - Wideband LNA - Design Narrowband LNA - Impedance Matching - Automatic Gain Control Amplifiers – Power Amplifiers

UNIT - II MIXERS**(9 Hrs)**

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion - Low Frequency Case: Analysis of Gilbert Mixer – Distortion - High-Frequency Case – Noise - A Complete Active Mixer. Switching Mixer - Distortion in Unbalanced Switching Mixer - Conversion Gain in Unbalanced Switching Mixer.

UNIT - III FREQUENCY SYNTHESIZERS**(9 Hrs)**

Phase Locked Loops - Voltage Controlled Oscillators - Phase Detector – Analog Phase Detectors – Digital Phase Detectors - Frequency Dividers - LC Oscillators - Ring Oscillators - Phase Noise - A Complete Synthesizer Design Example (DECT Application).

UNIT - IV SUB SYSTEMS**(9 Hrs)**

Analog-to-Digital Converters – Demodulators - A/D converters Used in a Receiver - Low-Pass Sigma-Delta Modulators - Band Pass Sigma-Delta Modulators - Implementation of Band Pass Sigma-Delta Modulators- I/Q mismatch in Mixer and A/D Converters - adaptive filters, Equalizers and transceivers.

UNIT - V IMPLEMENTATIONS**(9 Hrs)**

VLSI architecture for Multitier Wireless System - Hardware Design Issues for Next generation CDMA System

Text Books

1. B.Razavi, "RF Microelectronics", Prentice-Hall, 2012 second edition 2015
2. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2014.
3. Thomas H.Lee, "The Design of CMOS Radio –Frequency Integrated Circuits", Cambridge University Press, 2008. 2003
4. S.H.Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2016 1998
5. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge Press, 2005.

Reference Books

1. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI Wireless Design - Circuits and Systems", Kluwer Academic Publishers, 2000. (Paperback format 2013)
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 2012. (2nd edition 2016)

3. DALAL & UPENA, Wireless Communication, Oxford University Press, New Delhi, 2014.
4. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2007
5. Andreas Antoniou "Digital Filters" McGraw-Hill Science, 2000.

Web Resources

1. <http://www.wirelesscommunication.nl/reference/contents.htm>
2. https://www.tutorialspoint.com/wireless_communication.html
3. <http://www.nptelvideos.in/2012/12/wireless-communication.html>
4. <http://www.dsptechnologie.com/products/specialist-semiconductors/high-reliability-integrated-circuits>
5. ece.ut.ac.ir/silab/research/vlsi_comm.htm

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	1	-	-	1	1	-	1	-	-	-
2	2	2	1	1	2	1	1	-	1	1	-	1	-	-	-
3	2	1	1	1	2	-	-	-	-	-	-	-	-	-	-
4	2	1	1	1	2	-	-	-	-	-	-	1	-	-	-
5	2	1	1	1	2	1	1	-	1	1	-	1	1	-	-

Correlation Level: 1-Low, 2-Medium, 3-High

U20ECE827	5G WIRELESS COMMUNICATION SYSTEMS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- Learning the Basics of 5G and about 5G regulation protocol stack and its architecture.
- To understand the key technologies and enablers of 5G hardware technologies in 5G systems.
- To incorporate MIMO designs in 5G wireless systems analyze 5G wireless propagation channel models.
- To understand coordinated multi-point network architecture in 5G.
- To learn the new challenges in 5G modelling.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Map latest 5G Technology and its benefits with past technologies **(K2)**

CO2 - Learn the fundamentals of baseband and RF implementations in 5G using massive MIMO **(K2)**

CO3 - Attain knowledge about 5G Radio Access Technologies and its channel models **(K3)**

CO4 - Understand about 5G network architecture **(K3)**

CO5 - Implementation and evaluation of 5G and its applications **(K4)**

UNIT - I INTRODUCTION AND ROADMAP TO 5G

(9 Hrs)

Evolution of mobile technologies from 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G. Historical trend and evolution of LTE technology to beyond 4G – Key building blocks of 5G – 5G use cases and system concepts – The 5G Architecture – IoT: relation to 5G.

UNIT - II RF FRONT END FOR 5G

(9 Hrs)

Millimetre Wave Communications: Hardware technologies for mmW systems – Architecture and Mobility – Massive MIMO: Resource allocation and transceiver algorithms for massive MIMO - Fundamentals of baseband and RF implementations in massive MIMO – Beamforming- 3GPP and NYUSIM Channel Models

UNIT - III 5G WAVEFORMS AND CHANNEL MODELS

(9 Hrs)

5G Radio Access Technologies: Design principles - Multi-carrier with filtering - Non-orthogonal Multiple Access - Radio access for dense deployments – Radio Access for V2X Communication - Radio access for massive machine-type communication - 5G wireless propagation channel models: Modelling requirements and scenarios - The METIS channel models

UNIT - IV NETWORKING IN 5G

(9 Hrs)

Coordinated multi-point transmission in 5G: Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Buffer-aided relaying.

UNIT - V EVALUATION OF 5G AND 5G APPLICATIONS

(9 Hrs)

Machine-type communications: Fundamental techniques for MTC - Massive MTC - Ultra-reliable low-latency MTC - Device-to-device (D2D) communications - Multi-hop D2D communications - Multi-operator D2D communication - Simulation methodology: Evaluation methodology – Calibration - New challenges in the 5G modelling.

Text Books

1. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, - 5G Mobile Communications, Springer, 2017.
2. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, - 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.(Hardback format, 2019)
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", Taylor & Francis Inc, 2017

Reference Books

- 1 Jonathan rodriguez, - Fundamentals of 5G mobile networks, John Wiley & Sons, Ltd, 2015.
- 2 Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge,2011
- 3 University Press.D.R. Kamilo Feher Wireless Digital Communications, Prentice Hall of India, New Delhi.
- 4 Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications., 2014
- 5 Wong, Vincent WS, Robert Schober, Derrick Wing Kwan Ng, and Li-Chun Wang, eds. *Key technologies for 5G wireless systems*. Cambridge university press, 2017.

Web Resources

1. https://www.engineersgarage.com/article_page/5g-technology/
2. <https://www.techspot.com/guides/272-everything-about-5g/>
3. <https://pubmed.ncbi.nlm.nih.gov/27076701/>
4. <https://www.gsma.com/uploads/2019/04/The-5g>
5. <https://www.engpaper.com/5g-2018.htm>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	-	-	-	-	-	-	-	-	2	1	-	1
2	2	1	1	-	-	-	-	-	-	-	-	2	1	-	1
3	2	1	2	-	-	-	-	-	-	-	-	2	2	-	1
4	2	1	2	-	-	-	-	-	-	-	-	2	2	-	2
5	2	1	2	-	-	-	-	-	-	-	-	2	3	-	3

Correlation L1level: 1-Low, 2-Medium, 3-High

Course Objectives

- To know about basic of biomedical signal and its characteristics
- To learn about various signal conditioning circuits used in biomedical field
- To gain knowledge about basic measuring instruments in biomedical
- To study about the various assist devices used in the hospitals
- To understand recent trends in medical electronics

Course Outcomes

After completion of the course, the students will be able to

CO1 –Acquire the knowledge of basic of biomedical signal and various medical electrodes **(K2)**

CO2 – Gain the knowledge about various biomedical signal conditioning circuits **(K3)**

CO3 – Understand the working mechanism of basic bio signal measuring electronics instruments **(K3)**

CO4 – Interpret the various assist devices used in the hospitals viz. pacemakers, defibrillators, dialyzers and Ventilators **(K3)**

CO5 - Know about recent trends in medical electronics **(K2)**

UNT-I FUNDAMENTALS OF BIOMEDICAL ELECTRONICS**(9 Hrs)**

Sources of biomedical signals, Generalized medical instrumentation block diagram, Origin of bio potentials - characteristics – Frequency and amplitude ranges , Bio-potential electrodes, Types of electrodes - Surface; needle and micro electrodes, Medical electrode - ECG system, EEG electrode system, EMG, EOG, ERG-typical waveforms and signal characteristics.

UNIT-II BIO SIGNAL CONDITIONING CIRCUITS**(9 Hrs)**

Need for bio-amplifier – single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation – isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering.

UNIT-III CALIBRATION OF MEDICAL EQUIPMENT**(9 Hrs)**

Ventilator testers, SPO2analysers, NIBP analysers, Electro surgical analysers, Defibrillator analysers. Testing and maintenance of Heart lung machine, surgical lights, patient monitor, anaesthesia machine, dialyzer, surgical tools

UNIT-IV ASSISTING DEVICES**(9 Hrs)**

Blood pressure monitors – Electro-cardio scope - Pulse Oximeter - pH meter - Auto analyzer – Pacemakers – Defibrillator - Heart lung machine - Nerve and muscle stimulators - Dialysis machines - Surgical diathermy equipment – Nebulizer; inhalator - Aspirator – Humidifier - Ventilator and spirometry.

UNIT-V RECENT TRENDS IN MEDICAL ELECTRONICS**(9 Hrs)**

Digital radiography – CT - Basic Principle - Block diagram – Radioisotopes in medical diagnosis – Physics of radioactivity – Gamma Camera. Block diagram – SPECT Scanner – PET Scanner - Principles of NMR Imaging systems - Block diagram of NMR Imaging System – Ultrasonic Imaging Systems – Magnetic Resonance Imaging Systems.

Text Books

1. Leslie Cromwell, 'Biomedical Instrumentation and Measurement', Prentice Hall of India, New Delhi, second edition, 2014
2. R S Khandpur, "Handbook of Biomedical Instrumentation", 1st ed., Tata McGraw Hill Publishing Company Limited, 2014
3. Erich A. Pfeiffer, Fred J Weibell and Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice-Hall of India Pvt.Ltd, 2011

Reference Books

1. Khandpur, R.Stata, "Handbook of Biomedical Instrumentation", McGraw-Hill, New Delhi, 3rd edition 2014
2. John G.Webster, 'Medical Instrumentation Application and Design', 4rd edition, Wiley India Edition, 2015
3. Joseph J.Carr and John M.Brown John, "Introduction to Biomedical Equipment Technology", Wiley and Sons, New York, 4th edition, 2001
4. Shakthi Chatterjee & Aubert Miller, "Biomedical Instrumentation", CENGAGE Learning, 2012
5. Chanderlekha Goswami, "Handbook of Biomedical Instrumentation", Manglam Publications, 2010

Web Resources

1. https://en.wikipedia.org/wiki/Biomedical_engineering
2. <https://guides.lib.uh.edu/biomedical>
3. https://www.google.co.in/books/edition/Handbook_of_Biomedical_Instrumentation
4. <https://nptel.ac.in/courses/108/108/108108180/>
5. <https://nptel.ac.in/courses/102/105/102105090/>

COs/POs/PSOs Mapping

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1	3	-	-	-	-	1	-	-	1	1	-	1	3	-	-
2	3	1	2	1	2	2	-	1	1	1	-	1	3	2	1
3	3	1	1	1	1	2	-	1	1	1	-	1	3	-	-
4	3	1	1	1	1	3	-	1	1	1	-	1	3	2	-
5	3	1	2	1	2	3	2	1	1	1	-	1	3	2	1

Correlation Level: 1-Low, 2-Medium, 3-High

Course Objectives

- To gain knowledge about fundamentals of image processing.
- To understand the various image segmentation techniques.
- To extract features for image analysis.
- To introduce the concepts of Video Analytic Components
- To illustrate 3D image visualization.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Explain the fundamentals of image processing **(K2)**

CO2 - Learn and Analyze various image segmentation techniques **(K2)**

CO3 - Understand extract features for image analysis. **(K2)**

CO4 - Develop knowledge about the concepts of image registration and image fusion. **(K3)**

CO5 - Identify 3D image visualization. **(K3)**

UNIT - I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING**(9 Hrs)**

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms- DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing

UNIT - II SEGMENTATION**(9 Hrs)**

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods.

UNIT - III FEATURE EXTRACTION**(9 Hrs)**

First and second order edge detection operators, Phase congruency, Localized feature extraction detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Run length features, Fractal model based features, Gabor filter, wavelet features.

UNIT - IV VIDEO ANALYTIC COMPONENTS**(9 Hrs)**

Need for Video Analytics-Overview of video Analytics. Foreground extraction- Feature extraction- classifier – Pre-processing- edge detection- smoothing- Feature space-PCA-FLD-SIFT features

UNIT - V 3D IMAGE VISUALIZATION**(9 Hrs)**

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

Text Books

- 1 Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2015
- 2 Ardeshtir Goshtasby, " 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications", John Wiley and Sons, 2005.
- 3 John C.Russ, "The Image Processing Handbook", CRC Press 7th edition, Taylor & Francis Inc., 2015
- 4 Zhihao Chen (Author), Ye Yang, Jingyu Xue, Liping Ye, Feng Guo, The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video Analytics Suite, CreateSpace Independent Publishing Platform, 2014

Reference Books

- 1 Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", 2nd edition Academic Press, 2008.
- 2 R.C.Gonzalez and R.E. Woods, "Digital Image Processing ", 4th edition, Pearson, 2018
- 3 Rick S.Blum, Zheng Liu, "Multisensor image fusion and its Applications", Taylor & Francis, 2018.
4. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson Learning, 2013.
5. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill Education, 2009.

Web Resources

- 1 <http://eeweb.poly.edu/~onur/lectures/lectures.html>.
- 2 <http://www.caen.uiowa.edu/~dip/lecture/lecture.html>
- 3 <https://nptel.ac.in/courses/117105079/>
- 4 <https://nptel.ac.in/courses/108101113/>
- 5 <https://www.youtube.com/watch?v=GIL-h4IMgFk>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
2	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
3	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
4	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
5	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1

Correlation L1 level: 1-Low, 2-Medium, 3-High

ANNEXURE - II

1844

**SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE**

(An Autonomous Institution)

Puducherry - 605 107

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**Professional Elective**

Odd Semester: 2022-23

Subject Name: CAD for VLSI Circuits

Year/Semester: IV / VII

Course Code: U19ECE71

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32	191216	19TC0253	Yokesh.S	C	btechece191216@smvec.ac.in

IV-A

IV-B

IV-C

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2.4.2.27

**SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE**

(An Autonomous Institution)
Puducherry - 605 107

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Professional Elective

Odd Semester: 2022-23

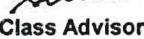
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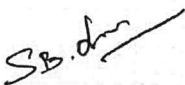
Year/Semester: IV / VII

Course Code: U19ECE72

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
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30	191034	19TC0131	Logeshprassanna.R	B	btechece191034@smvec.ac.in
31	190948	19TC0132	Lokkeswaran.P	B	btechece190948@smvec.ac.in
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33	190378	19TC0145	Muhammad Aadhil.M	B	btechece190378@smvec.ac.in
34	190588	19TC0150	Nandhini. P	B	btechece190588@smvec.ac.in
35	190970	19TC0159	Piradeep.R	B	btechece190970@smvec.ac.in
36	190559	19TC0162	Prasannavasani. V	B	btechece190559@smvec.ac.in
37	191035	19TC0166	Premalatha. S	B	btechece191035@smvec.ac.in

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
38	191036	19TC0171	Rajesh.J	B	btechece191036@smvec.ac.in
39	190905	19TC0174	Ramanathan. M	B	btechece190905@smvec.ac.in
40	190766	19TC0224	Surjiith. S	B	btechece190766@smvec.ac.in
41	190448	19TC0229	Swedha. J	B	btechece190448@smvec.ac.in
42	190287	19TC0235	Thirukumaran. M	B	btechece190287@smvec.ac.in
43	190716	19TC0052	Agarvin.B	C	btechece190716@smvec.ac.in
44	190762	19TC0056	Ajaydev.C.R	C	btechece190762@smvec.ac.in
45	191009	19TC0062	Anandavel .V	C	btechece191009@smvec.ac.in
46	190849	19TC0071	Balabharathi.V	C	btechece190849@smvec.ac.in
47	190524	19TC0083	Dharanidar.S	C	btechece190524@smvec.ac.in
48	190289	19TC0096	Gopinath.M	C	btechece190289@smvec.ac.in
49	191208	19TC0109	Jagadeesan.A	C	btechece191208@smvec.ac.in
50	190984	19TC0123	Kesavavarathan.K	C	btechece190984@smvec.ac.in
51	190045	19TC0165	Pravin Kumaar.C	C	btechece190045@smvec.ac.in
52	190553	19TC0170	Ragnal Kevin Jerome. A	C	btechece190553@smvec.ac.in
53	190557	19TC0178	Roshan Solomon .A	C	btechece190557@smvec.ac.in
54	191016	19TC0184	Santhiya.V	C	btechece191016@smvec.ac.in
55	191040	19TC0195	Sermalakshmi.P	C	btechece191040@smvec.ac.in
56	190527	19TC0198	Shrutii. E	C	btechece190527@smvec.ac.in
57	190864	19TC0200	Sivanesan.B	C	btechece190864@smvec.ac.in
58	190507	19TC0201	Sivaraj .T	C	btechece190507@smvec.ac.in
59	190617	19TC0219	Sundar Ganesh .N	C	btechece190617@smvec.ac.in
60	190686	19TC0222	Suraj.V	C	btechece190686@smvec.ac.in
61	190302	19TC0236	Thirumurugan.T	C	btechece190302@smvec.ac.in
62	190638	19TC0241	Velmurugan.P	C	btechece190638@smvec.ac.in
63	190851	19TC0248	Vineeth.R	C	btechece190851@smvec.ac.in

IV-A 
IV-B 
IV-C 
Class Advisors


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2. A. 2. 29

**SRI MAHAKULA VINAYAGAR ENGINEERING COLLEGE**

(An Autonomous Institution)

Puducherry - 605 107

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**Professional Elective**

Odd Semester: 2022-23

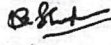
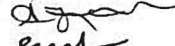
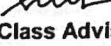
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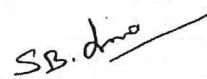
Year/Semester: IV / VII

Course Code: U19ECE73

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
1	191105	19TC0060	Alex Xavier	A	btechece191105@smvec.ac.in
2	190590	19TC0070	Azeess Basha G	A	btechece190590@smvec.ac.in
3	190718	19TC0081	Dhanush Jawahar Magee .M	A	btechece190718@smvec.ac.in
4	190299	19TC0084	Dhevipriyanka. S	A	btechece190299@smvec.ac.in
5	190838	19TC0088	Eswara Pandian. S	A	btechece190838@smvec.ac.in
6	190739	19TC0091	Gayathry R	A	btechece190739@smvec.ac.in
7	190194	19TC0094	Gokul. A	A	btechece190194@smvec.ac.in
8	190443	19TC0101	Harshavardhni. A	A	btechece190443@smvec.ac.in
9	190475	19TC0113	Jayapreethi K	A	btechece190475@smvec.ac.in
10	191199	19TC0121	Kaviya.M	A	btechece191199@smvec.ac.in
11	190680	19TC0128	Krishna Priya.K	A	btechece190680@smvec.ac.in
12	190446	19TC0151	Narmadha. S	A	btechece190446@smvec.ac.in
13	190410	19TC0160	Pradikksha. S	A	btechece190410@smvec.ac.in
14	190482	19TC0173	Rajeshvaran N	A	btechece190482@smvec.ac.in
15	190167	19TC0177	Riyaz Ahamad. S	A	btechece190167@smvec.ac.in
16	190923	19TC0182	Sankavi.S	A	btechece190923@smvec.ac.in
17	190953	19TC0186	Saran.A	A	btechece190953@smvec.ac.in
18	190900	19TC0204	Sneha.K	A	btechece190900@smvec.ac.in
19	190339	19TC0211	Sri Ram. R	A	btechece190339@smvec.ac.in
20	190515	19TC0212	Srivatsan G	A	btechece190515@smvec.ac.in
21	190997	19TC0237	Thiruvikraman.V	A	btechece190997@smvec.ac.in
22	190562	19TC0063	Anantapadmanaban R	B	btechece190562@smvec.ac.in
23	190510	19TC0085	Divyabharathi U	B	btechece190510@smvec.ac.in
24	190990	19TC0093	Gokul Krishnan. S	B	btechece190990@smvec.ac.in
25	190465	19TC0103	Hemamalini S	B	btechece190465@smvec.ac.in
26	190516	19TC0106	Humaira. C	B	btechece190516@smvec.ac.in
27	190979	19TC0111	Janani. M	B	btechece190979@smvec.ac.in
28	190910	19TC0122	Keerthivasan.V	B	btechece190910@smvec.ac.in
29	190785	19TC0124	Kirithiga. V	B	btechece190785@smvec.ac.in
30	190703	19TC0138	Manju S	B	btechece190703@smvec.ac.in
31	190576	19TC0142	Michael Antony .M	B	btechece190576@smvec.ac.in
32	191245	19TC0185	Sarah. S	B	btechece191245@smvec.ac.in
33	190084	19TC0206	Soundarya S	B	btechece190084@smvec.ac.in
34	190614	19TC0207	Sowmiya M	B	btechece190614@smvec.ac.in
35	191170	19TC0209	Srikkaanth. D	B	btechece191170@smvec.ac.in
36	190975	19TC0218	Sumanth. G.V.	B	btechece190975@smvec.ac.in

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
37	190981	19TC0220	Sunnivas. K	B	btechece190981@smvec.ac.in
38	190930	19TC0228	Suvetha Ve	B	btechece190930@smvec.ac.in
39	190492	19TC0242	Venisri T	B	btechece190492@smvec.ac.in
40	190417	19TC0252	Yogi Ram Kumar. M.S.	B	btechece190417@smvec.ac.in
41	190456	19TE0116	Nivetha.S	B	btechece190456@smvec.ac.in
42	190771	19TC0074	Balla Veera Venkata Durga Prasad	C	btechece190771@smvec.ac.in
43	191224	19TC0076	Chandranath.G	C	btechece191224@smvec.ac.in
44	190837	19TC0102	Hemabala. R	C	btechece190837@smvec.ac.in
45	191195	19TC0139	Manoj Lara.C	C	btechece191195@smvec.ac.in
46	190560	19TC0141	Meharaj. C	C	btechece190560@smvec.ac.in
47	190428	19TC0147	Nachellai.I	C	btechece190428@smvec.ac.in
48	190665	19TC0155	Naveen .P	C	btechece190665@smvec.ac.in
49	190720	19TC0158	Pampana Venkata Nikhil	C	btechece190720@smvec.ac.in
50	190946	19TC0172	Rajesh.P	C	btechece190946@smvec.ac.in
51	190347	19TC0189	Saritha.G	C	btechece190347@smvec.ac.in
52	190388	19TC0190	Sashanka Naga Sai Sunkara	C	btechece190388@smvec.ac.in
53	190732	19TC0203	Snega .R	C	btechece190732@smvec.ac.in
54	191232	19TC0205	Somnath. S	C	btechece191232@smvec.ac.in
55	190802	19TC0213	Stephen Jebakumar.S	C	btechece190802@smvec.ac.in
56	190991	19TC0223	Surender. V	C	btechece190991@smvec.ac.in
57	190355	19TC0226	Suryakumar.S	C	btechece190355@smvec.ac.in
58	191060	19TC0230	Swetha.A	C	btechece191060@smvec.ac.in

IV-A 
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Puducherry - 605 107

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Professional Elective

Odd Semester: 2022-23

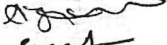
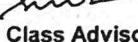
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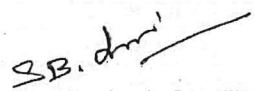
Year/Semester: IV / VII

Course Code: U19ECE75

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
1	190719	19TC0079	Devavasanth R	A	btechece190719@smvec.ac.in
2	190955	19TC0097	Goventhan. M	A	btechece190955@smvec.ac.in
3	191017	19TC0118	Kaniya Kayathri V	A	btechece191017@smvec.ac.in
4	190681	19TC0133	Madhumitha M	A	btechece190681@smvec.ac.in
5	190799	19TC0148	Nadaesh. D	A	btechece190799@smvec.ac.in
6	190951	19TC0168	Ragaventra.R	A	btechece190951@smvec.ac.in
7	190303	19TC0192	Saumya.V	A	btechece190303@smvec.ac.in
8	190731	19TC0202	Sivasankaran. M	A	btechece190731@smvec.ac.in
9	190783	19TC0225	Surya Raja. S	A	btechece190783@smvec.ac.in
10	190790	19TC0233	Thanush. M	A	btechece190790@smvec.ac.in
11	191189	19TC0234	Thatchitha. K	A	btechece191189@smvec.ac.in
12	20098044	19TCL004	Prasanth.K.N	A	btechece20098044@smvec.ac.in
13	20098234	19TCL005	Saranraj.M	A	btechece20098234@smvec.ac.in
14	190152	19TA0031	Vijay.R	B	btechece190152@smvec.ac.in
15	190394	19TC0058	Akshaya. I	B	btechece190394@smvec.ac.in
16	190694	19TC0061	Anandkumar C	B	btechece190694@smvec.ac.in
17	191213	19TC0065	Arivoomathi. P	B	btechece191213@smvec.ac.in
18	190535	19TC0067	Arunprasanth S	B	btechece190535@smvec.ac.in
19	190082	19TC0082	Dharani. A	B	btechece190082@smvec.ac.in
20	190828	19TC0092	Gogulakrishnan.P	B	btechece190828@smvec.ac.in
21	190148	19TC0095	Gokulakrishnan. K.S.	B	btechece190148@smvec.ac.in
22	190131	19TC0105	Hiran Lal. A	B	btechece190131@smvec.ac.in
23	191207	19TC0107	Indhuja. M	B	btechece191207@smvec.ac.in
24	190630	19TC0117	Kamalraj.A	B	btechece190630@smvec.ac.in
25	190343	19TC0119	Karthikcharan. D	B	btechece190343@smvec.ac.in
26	191209	19TC0125	Kirthana. A	B	btechece191209@smvec.ac.in
27	190098	19TC0140	Maria Jenifer E	B	btechece190098@smvec.ac.in
28	190792	19TC0156	Naveen. M	B	btechece190792@smvec.ac.in
29	190717	19TC0167	Priyadharshini V	B	btechece190717@smvec.ac.in
30	190469	19TC0169	Raghul A	B	btechece190469@smvec.ac.in
31	190377	19TC0176	Ranjith. S	B	btechece190377@smvec.ac.in
32	190656	19TC0188	Sargunal A	B	btechece190656@smvec.ac.in
33	190189	19TC0194	Seran. P	B	btechece190189@smvec.ac.in
34	190904	19TC0214	Subathra. V	B	btechece190904@smvec.ac.in
35	190188	19TC0240	Vasunthra. A	B	btechece190188@smvec.ac.in
36	190056	19TC0244	Vigneshvar. V	B	btechece190056@smvec.ac.in
37	191018	19TC0247	Vijayalakshmy .R	B	btechece191018@smvec.ac.in

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
38	20098246	19TCL001	Aravind.G	B	btechece20098246@smvec.ac.in
39	190017	19TI0007	Gautham Venkatesh	B	btechece190017@smvec.ac.in
40	190522	19TC0053	Aishwarya.L.S	C	btechece190522@smvec.ac.in
41	190422	19TC0080	Dhanraj. S	C	btechece190422@smvec.ac.in
42	191219	19TC0099	Harikaran. U	C	btechece191219@smvec.ac.in
43	190634	19TC0110	Janaki.S	C	btechece190634@smvec.ac.in
44	191246	19TC0116	Kailash.V	C	btechece191246@smvec.ac.in
45	190702	19TC0134	Maithili .S	C	btechece190702@smvec.ac.in
46	190568	19TC0164	Praveena. P	C	btechece190568@smvec.ac.in
47	190647	19TC0175	Ramya .T	C	btechece190647@smvec.ac.in
48	190701	19TC0179	Sandhiya V	C	btechece190701@smvec.ac.in
49	190494	19TC0183	Santhiya. S	C	btechece190494@smvec.ac.in
50	190760	19TC0197	Sharmila .M	C	btechece190760@smvec.ac.in
51	190276	19TC0210	Srinivas. V	C	btechece190276@smvec.ac.in
52	190715	19TC0216	Subiksha S	C	btechece190715@smvec.ac.in
53	191115	19TC0217	Sudhakar.S	C	btechece191115@smvec.ac.in
54	191179	19TC0245	Vigneshwarar.V	C	btechece191179@smvec.ac.in
55	191220	19TC0246	Vijay.B	C	btechece191220@smvec.ac.in
56	190440	19TC0254	Yuvalatchumi.S	C	btechece190440@smvec.ac.in
57	20098133	19TCL002	Elangkavi.K	C	btechece20098133@smvec.ac.in
58	20098542	19TCL003	Kaviyarasan. S	C	btechece20098542@smvec.ac.in
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(An Autonomous Institution)
Puducherry - 605 107

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Open Elective

Odd Semester: 2022-23

Subject Name: Hybrid and Electrical Vehicle

Year/Semester: IV / VII

Course Code: U19EE075

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
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3	190680	19TC0128	Krishna Priya.K	A	btechece190680@smvec.ac.in
4	190799	19TC0148	Nadaesh. D	A	btechece190799@smvec.ac.in
5	191008	19TC0153	Nasser Hussain. J	A	btechece191008@smvec.ac.in
6	190951	19TC0168	Ragaventra.R	A	btechece190951@smvec.ac.in
7	190303	19TC0192	Saumya.V	A	btechece190303@smvec.ac.in
8	190731	19TC0202	Sivasankaran. M	A	btechece190731@smvec.ac.in
9	190767	19TC0208	Sowmmiya. E	A	btechece190767@smvec.ac.in
10	190783	19TC0225	Surya Raja. S	A	btechece190783@smvec.ac.in
11	190997	19TC0237	Thiruvikraman.V	A	btechece190997@smvec.ac.in
12	190233	19TC0238	Vaasan C	A	btechece190233@smvec.ac.in
13	191172	19TC0251	Yogesh Krushna. R	A	btechece191172@smvec.ac.in
14	190152	19TA0031	Vijay.R	B	btechece190152@smvec.ac.in
15	190811	19TC0054	Aishwin. M	B	btechece190811@smvec.ac.in
16	191012	19TC0066	Arunkumar.N	B	btechece191012@smvec.ac.in
17	190723	19TC0073	Balavinayaga. S	B	btechece190723@smvec.ac.in
18	190510	19TC0085	Divyabharathi U	B	btechece190510@smvec.ac.in
19	190816	19TC0090	Gayathri. S	B	btechece190816@smvec.ac.in
20	190148	19TC0095	Gokulakrishnan. K.S.	B	btechece190148@smvec.ac.in
21	190516	19TC0106	Humaira. C	B	btechece190516@smvec.ac.in
22	190979	19TC0111	Janani. M	B	btechece190979@smvec.ac.in
23	190985	19TC0126	Kiruthivaas.E	B	btechece190985@smvec.ac.in
24	191034	19TC0131	Logeshprassanna.R	B	btechece191034@smvec.ac.in
25	190098	19TC0140	Maria Jenifer E	B	btechece190098@smvec.ac.in
26	190576	19TC0142	Michael Antony .M	B	btechece190576@smvec.ac.in
27	190588	19TC0150	Nandhini. P	B	btechece190588@smvec.ac.in
28	190970	19TC0159	Piradeep.R	B	btechece190970@smvec.ac.in
29	191035	19TC0166	Premalatha. S	B	btechece191035@smvec.ac.in
30	190469	19TC0169	Raghul A	B	btechece190469@smvec.ac.in
31	191036	19TC0171	Rajesh.J	B	btechece191036@smvec.ac.in
32	190772	19TC0199	Shurekha. S	B	btechece190772@smvec.ac.in
33	190084	19TC0206	Soundarya S	B	btechece190084@smvec.ac.in
34	190981	19TC0220	Sunnivas. K	B	btechece190981@smvec.ac.in
35	190766	19TC0224	Surjiith. S	B	btechece190766@smvec.ac.in
36	190448	19TC0229	Swedha. J	B	btechece190448@smvec.ac.in
37	190287	19TC0235	Thirukumaran. M	B	btechece190287@smvec.ac.in

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
38	190056	19TC0244	Vigneshvar. V	B	btechece190056@smvec.ac.in
39	191018	19TC0247	Vijayalakshmy .R	B	btechece191018@smvec.ac.in
40	190522	19TC0053	Aishwarya.L.S	C	btechece190522@smvec.ac.in
41	190771	19TC0074	Balla Veera Venkata Durga Prasad	C	btechece190771@smvec.ac.in
42	191173	19TC0098	Hari Krishnan.V	C	btechece191173@smvec.ac.in
43	191232	19TC0205	Somnath. S	C	btechece191232@smvec.ac.in
44	190276	19TC0210	Srinivas. V	C	btechece190276@smvec.ac.in
45	190991	19TC0223	Surender. V	C	btechece190991@smvec.ac.in
46	191179	19TC0245	Vigneshwarar.V	C	btechece191179@smvec.ac.in
47	191216	19TC0253	Yokesh.S	C	btechece191216@smvec.ac.in

IV-A

IV-B

IV-C

Class Advisors

Programme Academic Coordinator

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(An Autonomous Institution)
Madagadipet, Puducherry-605 107

**SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE**

(An Autonomous Institution)
Puducherry - 605 107

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**Open Elective****Odd Semester: 2022-23****Subject Name: Industrial Automation****Year/Semester: IV / VII****Course Code: U19IC075**

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
1	191004	19TC0051	Aakash.A	A	btechece191004@smvec.ac.in
2	190447	19TC0055	Ajay Ganesh. J	A	btechece190447@smvec.ac.in
3	191097	19TC0069	Aswin. S	A	btechece191097@smvec.ac.in
4	190831	19TC0072	Balamurugan. V	A	btechece190831@smvec.ac.in
5	190821	19TC0086	Easwarakumar. K	A	btechece190821@smvec.ac.in
6	190027	19TC0087	Erick Jeffery.N	A	btechece190027@smvec.ac.in
7	190435	19TC0089	Fleming Roland. P	A	btechece190435@smvec.ac.in
8	190443	19TC0101	Harshavardhni. A	A	btechece190443@smvec.ac.in
9	190890	19TC0108	Ishwar. V	A	btechece190890@smvec.ac.in
10	190509	19TC0112	Jayavignesh S	A	btechece190509@smvec.ac.in
11	191184	19TC0114	Jeevabharathi. T	A	btechece191184@smvec.ac.in
12	190824	19TC0115	Jeevan Sanjay. S	A	btechece190824@smvec.ac.in
13	190391	19TC0120	Kavin. S	A	btechece190391@smvec.ac.in
14	190038	19TC0137	Manivannan. P	A	btechece190038@smvec.ac.in
15	190842	19TC0146	Muthukumaran. A	A	btechece190842@smvec.ac.in
16	190859	19TC0149	Nandhidha. R	A	btechece190859@smvec.ac.in
17	190863	19TC0152	Naresh Kumar. M	A	btechece190863@smvec.ac.in
18	190745	19TC0157	Nivethitha. D	A	btechece190745@smvec.ac.in
19	190410	19TC0160	Pradikksha. S	A	btechece190410@smvec.ac.in
20	190921	19TC0180	Sanjay. C	A	btechece190921@smvec.ac.in
21	190491	19TC0181	Sanjay N	A	btechece190491@smvec.ac.in
22	190573	19TC0193	Sedhuraman. S	A	btechece190573@smvec.ac.in
23	190504	19TC0227	Suvetha. S	A	btechece190504@smvec.ac.in
24	191181	19TC0232	Thamizh Chemmal. S	A	btechece191181@smvec.ac.in
25	190822	19TC0239	Vanmuhil.B	A	btechece190822@smvec.ac.in
26	191106	19TC0243	Venkattheeban.V	A	btechece191106@smvec.ac.in
27	190785	19TC0124	Kirithiga. V	B	btechece190785@smvec.ac.in
28	190948	19TC0132	Lokkeswaran.P	B	btechece190948@smvec.ac.in
29	190949	19TC0144	Mohanprasath. R	B	btechece190949@smvec.ac.in
30	190378	19TC0145	Muhammad Aadhil.M	B	btechece190378@smvec.ac.in
31	190559	19TC0162	Prasannavasani. V	B	btechece190559@smvec.ac.in
32	190905	19TC0174	Ramanathan. M	B	btechece190905@smvec.ac.in
33	191245	19TC0185	Sarah. S	B	btechece191245@smvec.ac.in
34	190716	19TC0052	Agarvin.B	C	btechece190716@smvec.ac.in
35	190762	19TC0056	Ajaydev.C.R	C	btechece190762@smvec.ac.in
36	191009	19TC0062	Anandavel .V	C	btechece191009@smvec.ac.in
37	190849	19TC0071	Balabharathi.V	C	btechece190849@smvec.ac.in
38	191224	19TC0076	Chandranath.G	C	btechece191224@smvec.ac.in

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
39	190524	19TC0083	Dharanidar.S	C	btechece190524@smvec.ac.in
40	190289	19TC0096	Gopinath.M	C	btechece190289@smvec.ac.in
41	190837	19TC0102	Hemabala. R	C	btechece190837@smvec.ac.in
42	190726	19TC0104	Hera.V	C	btechece190726@smvec.ac.in
43	191208	19TC0109	Jagadeesan.A	C	btechece191208@smvec.ac.in
44	190634	19TC0110	Janaki.S	C	btechece190634@smvec.ac.in
45	190984	19TC0123	Kesavavarathan.K	C	btechece190984@smvec.ac.in
46	190702	19TC0134	Maithili .S	C	btechece190702@smvec.ac.in
47	191195	19TC0139	Manoj Lara.C	C	btechece191195@smvec.ac.in
48	190045	19TC0165	Pravin Kumar.C	C	btechece190045@smvec.ac.in
49	190647	19TC0175	Ramya .T	C	btechece190647@smvec.ac.in
50	190557	19TC0178	Roshan Solomon .A	C	btechece190557@smvec.ac.in
51	190494	19TC0183	Santhiya. S	C	btechece190494@smvec.ac.in
52	190347	19TC0189	Saritha.G	C	btechece190347@smvec.ac.in
53	190864	19TC0200	Sivanesan.B	C	btechece190864@smvec.ac.in
54	190617	19TC0219	Sundar Ganesh .N	C	btechece190617@smvec.ac.in
55	190686	19TC0222	Suraj.V	C	btechece190686@smvec.ac.in
56	191060	19TC0230	Swetha.A	C	btechece191060@smvec.ac.in
57	190302	19TC0236	Thirumurugan.T	C	btechece190302@smvec.ac.in
58	190638	19TC0241	Velmurugan.P	C	btechece190638@smvec.ac.in
59	190851	19TC0248	Vineeth.R	C	btechece190851@smvec.ac.in
60	20098542	19TCL003	Kaviyaran. S	C	btechece20098542@smvec.ac.in

IV-A

IV-B

IV-C

J. Soudarshan
(J. Soudarshan)
(J. Soudarshan)
 Class Advisors

S.R. Lenin
 Programme Academic Coordinator
 Dr.S.B.Lenin

Dr. P. Raja
 Dr.P.Raja

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**Open Elective**

Odd Semester: 2022-23

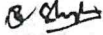
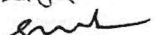
Subject Name: Data Science using python

Year/Semester: IV / VII

Course Code: U19CCO75

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
1	191105	19TC0060	Alex Xavier	A	btechece191105@smvec.ac.in
2	190719	19TC0079	Devavasanth R	A	btechece190719@smvec.ac.in
3	190838	19TC0088	Eswara Pandian. S	A	btechece190838@smvec.ac.in
4	190900	19TC0204	Sneha.K	A	btechece190900@smvec.ac.in
5	190339	19TC0211	Sri Ram. R	A	btechece190339@smvec.ac.in
6	20098044	19TCL004	Prasanth.K.N	A	btechece20098044@smvec.ac.in
7	20098234	19TCL005	Saranraj.M	A	btechece20098234@smvec.ac.in
8	190325	19TC0075	Bangayar Selvi.N.G	B	btechece190325@smvec.ac.in
9	190828	19TC0092	Gogulakrishnan.P	B	btechece190828@smvec.ac.in
10	190846	19TC0100	Harini. K	B	btechece190846@smvec.ac.in
11	190465	19TC0103	Hemamalini S	B	btechece190465@smvec.ac.in
12	191209	19TC0125	Kirthana. A	B	btechece191209@smvec.ac.in
13	190703	19TC0138	Manju S	B	btechece190703@smvec.ac.in
14	190717	19TC0167	Priyadharshini V	B	btechece190717@smvec.ac.in
15	190554	19TC0187	Sarath Chandiran S	B	btechece190554@smvec.ac.in
16	190656	19TC0188	Sargunal A	B	btechece190656@smvec.ac.in
17	190336	19TC0191	Sathya Moorthy. J	B	btechece190336@smvec.ac.in
18	190614	19TC0207	Sowmiya M	B	btechece190614@smvec.ac.in
19	191170	19TC0209	Srikkaanth. D	B	btechece191170@smvec.ac.in
20	190975	19TC0218	Sumanth. G.V.	B	btechece190975@smvec.ac.in
21	190930	19TC0228	Suvetha Ve	B	btechece190930@smvec.ac.in
22	190188	19TC0240	Vasunthra. A	B	btechece190188@smvec.ac.in
23	190417	19TC0252	Yogi Ram Kumar. M.S.	B	btechece190417@smvec.ac.in
24	20098246	19TCL001	Aravind.G	B	btechece20098246@smvec.ac.in
25	190456	19TE0116	Nivetha.S	B	btechece190456@smvec.ac.in
26	190705	19TC0059	Alagamma.V	C	btechece190705@smvec.ac.in
27	190610	19TC0068	Aswin.Z	C	btechece190610@smvec.ac.in
28	190422	19TC0080	Dhanraj. S	C	btechece190422@smvec.ac.in
29	190927	19TC0130	Logesh.R	C	btechece190927@smvec.ac.in
30	190720	19TC0158	Pampana Venkata Nikhil	C	btechece190720@smvec.ac.in
31	190473	19TC0161	Prakash.V	C	btechece190473@smvec.ac.in
32	190568	19TC0164	Praveena. P	C	btechece190568@smvec.ac.in
33	190553	19TC0170	Ragnal Kevin Jerome. A	C	btechece190553@smvec.ac.in
34	190388	19TC0190	Sashanka Naga Sai Sunkara	C	btechece190388@smvec.ac.in
35	190527	19TC0198	Shrutii. E	C	btechece190527@smvec.ac.in
36	190507	19TC0201	Sivaraj .T	C	btechece190507@smvec.ac.in
37	190802	19TC0213	Stephen Jebakumar.S	C	btechece190802@smvec.ac.in

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
38	190715	19TC0216	Subiksha S	C	btechece190715@smvec.ac.in
39	190355	19TC0226	Suryakumar.S	C	btechece190355@smvec.ac.in
40	190845	19TC0231	Swetha.R	C	btechece190845@smvec.ac.in
41	190631	19TC0249	Vishwaa. M	C	btechece190631@smvec.ac.in
42	20098133	19TCL002	Elangkavi.K	C	btechece20098133@smvec.ac.in
43	20098122	19TCL006	Saravanan.P	C	btechece20098122@smvec.ac.in

IV-A 
IV-B 
IV-C 
Class Advisors


Programme Academic Coordinator
Dr.S.B.Lenin


MOD
Dr. P. Rajar
Professor and Head
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**Open Elective**

Odd Semester: 2022-23

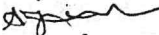
Subject Name: Artificial Intelligence Applications

Year/Semester: IV / VII

Course Code: U19ADO74

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
1	190548	19TC0057	Akshaya S	A	btechece190548@smvec.ac.in
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3	190590	19TC0070	Azeess Basha G	A	btechece190590@smvec.ac.in
4	190409	19TC0077	Charulatha. M	A	btechece190409@smvec.ac.in
5	190309	19TC0078	Deepika. S	A	btechece190309@smvec.ac.in
6	190299	19TC0084	Dhevipriyanka. S	A	btechece190299@smvec.ac.in
7	190739	19TC0091	Gayathry R	A	btechece190739@smvec.ac.in
8	190194	19TC0094	Gokul. A	A	btechece190194@smvec.ac.in
9	190955	19TC0097	Goventhan. M	A	btechece190955@smvec.ac.in
10	191017	19TC0118	Kaniya Kayathri V	A	btechece191017@smvec.ac.in
11	191199	19TC0121	Kaviya.M	A	btechece191199@smvec.ac.in
12	190681	19TC0133	Madhumitha M	A	btechece190681@smvec.ac.in
13	190511	19TC0143	Mohamed Faisal B	A	btechece190511@smvec.ac.in
14	190446	19TC0151	Narmadha. S	A	btechece190446@smvec.ac.in
15	190945	19TC0154	Naveen Chander. P	A	btechece190945@smvec.ac.in
16	191166	19TC0163	Prathela. T	A	btechece191166@smvec.ac.in
17	190482	19TC0173	Rajeshvaran N	A	btechece190482@smvec.ac.in
18	190167	19TC0177	Riyaz Ahamad. S	A	btechece190167@smvec.ac.in
19	190923	19TC0182	Sankavi.S	A	btechece190923@smvec.ac.in
20	190953	19TC0186	Saran.A	A	btechece190953@smvec.ac.in
21	191021	19TC0196	Shakila. T	A	btechece191021@smvec.ac.in
22	190515	19TC0212	Srivatsan G	A	btechece190515@smvec.ac.in
23	190033	19TC0215	Subhiksha. R	A	btechece190033@smvec.ac.in
24	190790	19TC0233	Thanush. M	A	btechece190790@smvec.ac.in
25	191189	19TC0234	Thatchitha. K	A	btechece191189@smvec.ac.in
26	190394	19TC0058	Akshaya. I	B	btechece190394@smvec.ac.in
27	190694	19TC0061	Anandkumar C	B	btechece190694@smvec.ac.in
28	190562	19TC0063	Anantapadmanaban R	B	btechece190562@smvec.ac.in
29	191213	19TC0065	Arivoomathi. P	B	btechece191213@smvec.ac.in
30	190535	19TC0067	Arunprasanth S	B	btechece190535@smvec.ac.in
31	190082	19TC0082	Dharani. A	B	btechece190082@smvec.ac.in
32	190990	19TC0093	Gokul Krishnan. S	B	btechece190990@smvec.ac.in
33	190131	19TC0105	Hiran Lal. A	B	btechece190131@smvec.ac.in
34	191207	19TC0107	Indhuja. M	B	btechece191207@smvec.ac.in
35	190630	19TC0117	Kamalraj.A	B	btechece190630@smvec.ac.in
36	190343	19TC0119	Karthikcharan. D	B	btechece190343@smvec.ac.in
37	190910	19TC0122	Keerthivasan.V	B	btechece190910@smvec.ac.in

S.No	Enroll No	Regn.No.	Name of the Student	Section	Email ID
38	190437	19TC0136	Manikandan. D	B	btechece190437@smvec.ac.in
39	190792	19TC0156	Naveen. M	B	btechece190792@smvec.ac.in
40	190377	19TC0176	Ranjith. S	B	btechece190377@smvec.ac.in
41	190189	19TC0194	Seran. P	B	btechece190189@smvec.ac.in
42	190904	19TC0214	Subathra. V	B	btechece190904@smvec.ac.in
43	190492	19TC0242	Venisri T	B	btechece190492@smvec.ac.in
44	190017	19TI0007	Gautham Venkatesh	B	btechece190017@smvec.ac.in
45	191219	19TC0099	Harikaran. U	C	btechece191219@smvec.ac.in
46	191246	19TC0116	Kailash.V	C	btechece191246@smvec.ac.in
47	190793	19TC0127	Krishnan.G	C	btechece190793@smvec.ac.in
48	190583	19TC0129	Kugan A	C	btechece190583@smvec.ac.in
49	190958	19TC0135	Manibharathi.R	C	btechece190958@smvec.ac.in
50	190560	19TC0141	Meharaj. C	C	btechece190560@smvec.ac.in
51	190428	19TC0147	Nachellai.I	C	btechece190428@smvec.ac.in
52	190665	19TC0155	Naveen .P	C	btechece190665@smvec.ac.in
53	190946	19TC0172	Rajesh.P	C	btechece190946@smvec.ac.in
54	190701	19TC0179	Sandhiya V	C	btechece190701@smvec.ac.in
55	191016	19TC0184	Santhiya.V	C	btechece191016@smvec.ac.in
56	191040	19TC0195	Sermalakshmi.P	C	btechece191040@smvec.ac.in
57	190760	19TC0197	Sharmila .M	C	btechece190760@smvec.ac.in
58	190732	19TC0203	Snega .R	C	btechece190732@smvec.ac.in
59	191115	19TC0217	Sudhakar.S	C	btechece191115@smvec.ac.in
60	191220	19TC0246	Vijay.B	C	btechece191220@smvec.ac.in
61	190065	19TC0250	Yamini Krishna.G	C	btechece190065@smvec.ac.in
62	190440	19TC0254	Yuvalatchumi.S	C	btechece190440@smvec.ac.in

IV-A 
IV-B 
IV-C 
Class Advisors


Programme Academic Coordinator
Dr.S.B.Lenin


Dr. R. RAJA
Prof. Dr. R. Raja
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2. A. 2. 42



SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE

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Puducherry - 605 107

**5th UG - Board of Studies Meeting in the department of
Electronics and Communication Engineering**

for the Programme

M.Tech – Electronics and Communication Engineering

M.Tech – VLSI and Embedded Systems

P.hD – Electronics and Communication Engineering

Venue

Seminar Hall, Department of ECE
Sri Manakula Vinayagar Engineering College
Madagadipet, Puducherry – 605 107

Date & Time

17-09-2022 & 11.30 am

BOARD OF STUDIES MEETING

The Fifth Board of Studies meeting for PG and Research programmes was held on 17th September 2022 at 11:30 am in the Seminar Hall, Department of ECE, Sri Manakula Vinayagar Engineering College with the Head of the Department in the Chair.

The following members were present for the BoS meeting in the venue

Sl. No	Name of the Member	Designation
1	Dr. P. Raja Professor and Head, Department of ECE	Chairman
2	Mr. C. Gnanavel General Manager, Production and Technology, Lenovo India Ltd., Puducherry	Industry Member
3	Dr.V.Bharathi , Professor / ECE Specialization: Wireless Communication	Member
4	Dr.R.Ramya , Professor/ ECE Specialization: ECE	Member
5	Dr. J.Pradeep , Associate Professor / ECE Specialization: Image Processing	Member
6	Dr. R.Kurinjimalar , Associate Professor / ECE Specialization: Mobile Satellite Communication	Member

Department of ECE – Fifth BoS Meeting (PG and Research Programs)

7	Dr. N.Jothy , Associate Professor / ECE Specialization: Wireless Communication	Member
8	Prof. R. Ilaiyaraja , Assistant Professor / ECE Specialization: VLSI Design	Member
9	Prof.Egalite Francis , Assistant Professor Specialization: Mathematics	Member
10	Prof. K. Oudayakumar , Associate Professor Specialization: Physics	Member
11	Dr. S. Deepa , Professor Specialization: Chemistry	Member
12	Dr.D.Jaichithra , Associate Professor Specialization: English	Member
13	Mr. Dharanidharan. G Associated Functional Consultant, Birlasoft Limited, Old Mahabalipuram Road, Chennai – 600096	Alumni Member

The following members were present in the online platform

Sl. No	Name of the Member	Designation
1	Dr. Gerardine Immaculate Mary Professor, Department of Embedded Systems, Vellore Institute of Technology (VIT), Vellore, Tamil Nadu, India	Expert Member (University Nominee)
2	Dr. N. Venkateswaran Professor, Department of ECE, SSN - College of Engineering, Kalavakkam, Tamil Nadu, India	Expert Member (Academic Council Nominee)
3	Dr. V. R. Vijayakumar Associate Professor & Head, Department of ECE, Anna University, Regional Campus, Coimbatore	Expert Member (Academic Council Nominee)

AGENDA OF THE MEETING

BoS /2022 /PG/ECE 5.1

To review and confirm the minutes of fourth BoS meeting held on 26th February 2022

BoS /2022 /PG/ECE 5.2

To ratify the Internship course for PG programmes from the Academic Year 2021-22 onwards

BoS /2022 /PG/ECE 5.3

To consider and approve the syllabi of advanced courses offered to the research program (Ph.D - Electronics and Communication Engineering) based on the suggestions from Doctoral Committee

BoS /2022 /PG/ECE 5.4

Any other item with the permission of chair

MINUTES OF THE MEETING

Dr. P. Raja, Chairman, BoS opened the meeting with warm welcome and thanked all the Members for accepting the Fifth BoS meeting Invitation for the M. Tech and Research programmes. The Chairman proceeded the meeting subsequently and discussed the agenda items.

BoS / 2022/ PG / ECE 5.1

To review and confirm the fourth BoS meeting minutes held on 26th February 2022

The Fourth BoS Meeting for M.Tech.- Electronics and Communication Engineering and M. Tech – VLSI and Embedded Systems under Regulations 2020 held on February 26, 2022 and minutes are reviewed and confirmed

Minutes are Reviewed and Confirmed

BoS / 2022 / PG / ECE 5.2

To ratify the Internship course for PG programmes from the Academic Year 2021-22 onwards

The following students from M.Tech Electronics Communication Engineering programme undergone enrolled the Internship courses

Enroll No.	Register No	Name of the Student	Company Details	Duration
20098226	20PEC001	S. Priyadharshini	Kinney Infotech	20 days
20098559	20PEC002	M. VidhyaBharathi	Pantech e Learning	20 days

The following students from M.Tech VLSI and Embedded Systems programme undergone enrolled the Internship courses

Enroll No.	Register No.	Name of the Student	Company Details	Duration
20098456	20PVE001	Bharathi G	Bistate Systems	39 days
20098436	20PVE002	Dhanush R	Bistate Systems	39 days
20098142	20PVE003	Gayathri S	Student Semiconductors	72 days
20098221	20PVE004	Sivashankari S	Bitsilica	45 days

Members are appreciated the progress of the students in Internship course

BoS/2022 / PG /ECE 5.3

To consider and approve the syllabi of advanced courses offered to the research program (Ph.D - Electronics and Communication Engineering) based on the suggestions from Doctoral Committee

The research scholars shall take the coursework examination consisting of written Papers of 3 hours duration each and a maximum mark of 100 for each Paper, the following basic courses are mandatory courses for each research scholar

1. Research Methodology
2. Research and Publication Ethics

Department of ECE – Fifth BoS Meeting (PG and Research Programs)

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In addition to that, Doctoral Committee recommended the following advanced courses to the research scholars based on the research area.

S.No	Name of the Candidate	Research Area	Advanced course details
1	H.Arivazhagan	Wireless Communication	1. Massive MIMO 2. Digital Systems Design Using VHDL and Advanced Computer Arithmetic
2	M.Harikrishnan	Image Processing	• Deep Learning • Machine Learning Techniques
3	S.Jayanthi	VLSI	• Semiconductor Memory Design and Testing • Semiconductor Device and Modeling
4	J.Jeevanantham	Process Control	• Advanced Process Control • Intelligent Control Techniques
5	K.Priethamje Vithya	Wireless Communication	• Advanced Antenna Systems • Advanced Wireless Technologies
6	S.Sivasankari	Wireless Communication	• Antenna Theory and Design • RF Passive Circuit Design
7	T.Sudha	Sensors Networks with Artificial Intelligence	• Biomedical Sensors and Instrumentation • Artificial Intelligence

Noted and recommended for Academic Council Approval

BoS / 2022 / PG / ECE 5.4

Any other item with the permission of chair

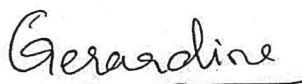
- Members insisted to motivate the research scholars to publish the research papers in reputed Journals
- Members appreciated the conduction of Dc meet as per regulations

Dr. P. Raja, Chairman – BoS and Head of Department, Electronics and Communication Engineering, concluded the meeting at 12.30 pm with vote of thanks.



Dr. P. RAJA

Board Chairman - ECE

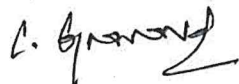


Dr.GERARDINE IMMACULATE MARY

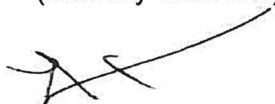
Professor, Department of Embedded Systems,
Vellore Institute of Technology (VIT), Vellore
(Expert Member - University Nominee)



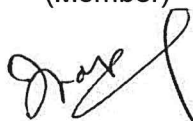
Dr. N. VENKATESWARAN
Professor, Department of ECE,
SSN College of Engineering, Kalavakkam
(Expert Member – AC Nominee)



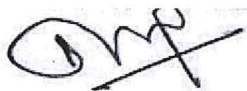
Mr. C. GNANA VEL
Manager, Production and Technology,
Lenovo India Ltd., Puducherry
(Industry .Member)



Dr. R. RAMYA
Professor/ ECE
(Member)



Dr. J. PRADEEP
Associate Professor / ECE
(Member)



Prof. R. ILAIYARAJA,
Assistant Professor / ECE
(Member)



Dr. D. JAICHITHRA
Professor / English
(Member)



Prof. K. OUDAYAKUMAR
Associate Professor / Physics
(Member)



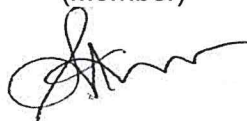
Dr. V. R. VIJAYAKUMAR
Associate Professor & Head, Department of
ECE, Anna University, Regional Campus,
Coimbatore
(Expert Member – AC Nominee)



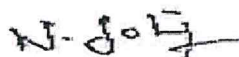
Mr. DHARANIDHARAN. G
Associated Functional Consultant,
Birlasoft Limited, Chennai
(Alumni Member)



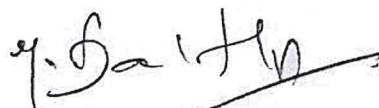
Dr. V. BHARATHI
Professor / ECE
(Member)



Dr. R. KURINJIMALAR
Associate Professor / ECE
(Member)



Dr. N. JOTHY
Associate Professor / ECE
(Member)



Prof. EGALITE FRANCIS
Assistant Professor / Mathematics
(Member)



Dr. S. DEEPA
Professor / Chemistry
(Member)

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ANNEXURE – I

R-2019

U19ECT81	CYBER PHYSICAL SYSTEM AND SECURITY	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives:

- To understand the overview of cyber-physical system and its different application domains
- To know the hardware and software platforms of cyber-physical system
- To gain knowledge about the synchronous and asynchronous models of CPS
- To learn about the cyber-physical system safety and security.
- To provide adequate knowledge about security in operating system and network.

Course Outcomes:

After completion of the course, the students will be able to

- CO1 - Able to have understanding of the core principle behind the cyber-physical system (K2)
- CO2 - Gain an overview of the hardware and software platform of cyber-physical system (K2)
- CO3 - Identify and analyse the synchronous and asynchronous model of cyber-physical system (K3)
- CO4 - Describe the cyber-physical system safety and security (K3)
- CO5 - Acquire clear knowledge about security in operating system and network(K4)

UNIT-I INTRODUCTION TO CYBER-PHYSICAL SYSTEM

(9 Hrs)

Introduction to Cyber-Physical Systems (CPS), Basic principles of design and validation of CPS, CPS requirements, Challenges in cyber-physical system, Industry standards, Key features of cyber-physical systems, Application of CPS- industry 4.0, AutoSAR, IIOT implications, Building automation, Medical CPS.

UNIT-II CPS HARDWARE AND SOFTWARE PLATFORM

(9 Hrs)

CPS hardware platforms: Processors-Types of processor, Parallelism, Sensors- Model of sensor, Sensor types, Actuators, Memory architectures-Memory technologies, Memory hierarchy, Memory model, CPS network – Wireless Hart, CAN, Automotive Ethernet, CPS software stack – RTOS, Scheduling real-time control tasks.

UNIT-III SYNCHRONOUS AND ASYNCHRONOUS MODEL

(9Hrs)

Synchronous model: Reactive components, Properties of components, Composing components, synchronous design, Synchronous circuits, Cruise control system, Synchronous networks, Asynchronous model: Asynchronous processes- Asynchronous design primitives, Coordination protocols- Leader election, Reliable transmission, Wait-free consensus, Real-time scheduling: Scheduling concepts, EDF scheduling, Fixed – Priority scheduling.

UNIT-IV CYBER PHYSICAL SYSTEM SAFETY & SECURITY

(9Hrs)

CPS Safety specification, verifying invariants, Enumerative Search, Symbolic search, Cyber Security requirement, Attack models, secure task mapping and partitioning, state estimation for attack detection, Advanced Techniques –System theoretic approaches, automotive case study vehicle ABS hacking, Power distribution case study, attacks on smart grids.

UNIT V SECURITY IN OPERATING SYSTEM & NETWORK

(9Hrs)

Security in Operating Systems - Security in the Design of Operating Systems -Rootkit - Network security attack- Threats to Network Communications - Wireless Network Security - Denial of Service - Distributed Denial-of-Service.

Text Books

1. E.A.Lee & S.A.Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", PHI Learning Private Limited, 4th Edition, 2019.
2. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press, 2015.
3. Raj Rajkumar, "Cyber-Physical Systems", Elsevier, 2nd Edition, 2015.
4. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition , Pearson Education , 2015

Reference Books

1. Houbing Song, Danda.B. Rawat & Sabina Jeschke, "Cyber physical system, Foundations, Principles and Application", Todd Green, Elsevier, 2017.
2. Edward D Lamie, "Computing Fundamentals of Cyber Physical Systems", Newnes Elsevier Publication, 2nd Edition, 2011.
3. Andrea Bondavalli, Sara Bouchnak & Hermann Kopetz, "Cyber-physical systems of systems: Foundations-A conceptual model and some derivations", Springer Nature, 2016.
4. Andre Platzer, "Logical Foundations of Cyber-Physical System", Springer, 2018.
5. Gaddadevara Matt Siddesh, Ganesh Chandra Deka, Krishnaraja nagar Gopalalyengar Srinivasa, Lait Mogan Patnaik, "Cyber-Physical systems-A Computational Perspective", CRC Press, 2015.

Web Resources

1. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs24/>
2. <https://www.nist.gov/el/cyber-physical-systems>
3. <https://www.sciencedirect.com/topics/engineering/cyber-physical-systems>
4. <https://www.coursera.org/learn/cyber-physical-systems-1>
5. <https://www.elsevier.com/books/cyber-physical-systems/song/978-0-12-803801-7>

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-
2	3	1	-	-	-	-	-	-	-	-	-	-	2	1	-
3	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
4	3	2	2	2	1	-	-	-	-	-	-	-	3	2	1
5	3	2	2	2	1	1	-	-	-	-	-	-	3	2	1

Correlation Level: 1-Low, 2-Medium, 3- High

Course Objectives

- To give exposure on the band diagram of compound Semiconductor Material.
- To understand the characteristics and Structure of BJT
- To understand the characteristics and Structure of MOSFET
- To acquire Knowledge about Power Devices
- To create awareness about Photonic devices and Sensors

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand the concept of Semiconductor Material and its Characteristics. **(K2)**

CO2 – Discuss about BJT and its characteristics. **(K2)**

CO3 – Describe the structure and characteristics of MOSFET. **(K2)**

CO4 – Describe about the power devices and their characteristics. **(K2)**

CO5 – Apply the knowledge of photonic devices and sensors to various applications. **(K3)**

UNIT - I SEMICONDUCTOR MATERIAL CHARACTERISTICS

(9 Hrs)

Crystal structure of Si, GaAs - electrons in periodic lattices - energy band and energy band gap - carrier concentration at thermal equilibrium and carrier transport phenomenon - phonon- optical – thermal properties.

UNIT - II BIPOLAR TRANSISTORS

(9 Hrs)

Introduction – Static characteristics of BJT – basic current voltage relationship - microwave characteristics of BJT – small signal characteristics - related device structures – Heterojunction bipolar transistor.

UNIT - III MOSFETs

(9 Hrs)

Introduction – basic device characteristics – non uniform doping and buried channel device – device scaling and short channel effects – MOSFET structures – circuit applications.

UNIT - IV POWER DEVICES

(9 Hrs)

Tunnel diode – related tunnel devices – IMPATT diodes – Static and Dynamic characteristics – power and efficiency – BARITT diode and TUNNETT diode – Thyristor – Thyristor characteristics.

UNIT - V PHOTONIC DEVICES, SENSORS AND APPLICATIONS

(9 Hrs)

Light emitting diode – photoconductor – photodiodes – avalanche photodiode – phototransistor – charge coupled device – Thermal , mechanical , magnetic and chemical sensors.

Textbooks

- 1 Nandita Das Gupta and Amitava Das Gupta, "Semiconductor Devices: Modeling and Technology", Prentice Hall of India, 2004.
- 2 S. M. Sze, "Physics of Semiconductor Devices", 3rd edition, John Wiley and Sons, 2007.
- 3 Donald A Neamen, Semiconductor Physics and Devices: Basic Principles, McGraw-Hill, 2011.

Reference Books

1. M.S.Tyagi, "Introduction to Semiconductor Materials and Devices", John Wiley and Sons, 2008.
2. J.Singh, "Semiconductor Devices: Basic Principles", John Wiley and Sons, 2007.
3. J.P.McKelvey, Introduction to Solid State and Semiconductor Physics, Harper and Row and John Weather Hill.
4. P. Bhattacharya, Semiconductor Optoelectronics Devices, 2nd Edition, PHI, 2009.

Web Resources

- 1 <https://nptel.ac.in/courses/117104071/>
- 2 <https://cosmolearning.org/courses/high-speed-devices-circuits/>
- 3 <https://www.doccity.com/en/lecture-notes/subjects/high-speed-electron-devices/>
- 4 <https://www.researchgate.net/journal/International-Journal-of-High-Speed-Electronics-and-Systems-0129-1564>
- 5 <https://ieeexplore.ieee.org/document/6647520>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	-	-	-	-	-	-	-	-	1	2	-	-
2	2	1	1	-	-	-	-	-	-	-	-	1	2	-	-
3	2	1	1	-	-	-	-	-	-	-	-	1	2	-	-
4	2	1	1	-	-	-	-	-	-	-	-	1	2	-	-
5	2	1	1	-	-	-	-	-	-	-	-	1	2	-	-

Correlation Level: 1-Low, 2-Medium, 3-High

Course Objectives

- Understand the principles of machine learning and apply the fundamental principles Data acquisition, pre-processing
- Apply machine learning principles algorithms based on supervised learning
- Understand optimization and dimensionality reduction using unsupervised learning
- To learn neural and deep neural networks for parallel processing
- To develop intelligent applications by applying the principles of machine learning

Course Outcomes

After completion of the course, the students will be able to

CO1 – Know the basic principles of machine learning **(K2)**

CO2 – Understand supervised learning algorithms and its basic classifications **(K2)**

CO3 – Optimize the performance using clustering algorithms **(K3)**

CO4 – Compare neural and deep neural networks for parallel processing **(K3)**

CO5 – Develop applications based on the concepts of machine learning **(K4)**

UNIT - I INTRODUCTION

(9 Hrs)

Data acquisition, pre-processing, feature extraction and processing, feature ranking/selection, feature reduction, model learning, evaluation, deployment. Matrix algebra Feature Scaling, Learning Rate, Normal Equation, Features and Polynomial Regression, Logistic Regression-classification, hypothesis representation, decision boundary, cost function, optimization, multiclass classification.

UNIT - II SUPERVISED LEARNING

(9Hrs)

Machine Learning Algorithms - KNN, SVM, Random Forest. Decision trees, Inductive bias, Classification, Regression, Perceptron, Tree learning algorithms. Model Selection and Generalization. Dimensions of a Supervised Machine Learning Algorithm

UNIT - III UNSUPERVISED LEARNING

(9Hrs)

Introduction, k-means algorithm, optimization, random initialization, clustering. Dimensionality Reduction: Data compression, visualization, principal component analysis algorithm, reconstruction from compressed representation.

UNIT - IV NEURAL NETWORKS

(9Hrs)

Artificial neurons, Neural Networks as a Paradigm for Parallel Processing. The Perceptron Gradients and back propagation, Gradient decent, Convolution neural networks: continuous convolution, discrete convolution, pooling. Recurrent neural networks. Deep neural networks.

UNIT - V APPLICATIONS

(9Hrs)

Development of an application of machine learning; for example, Optical Character Recognition, Email spam identification, etc Machine Learning for communication: signal processing, adaptive filtering, modulation, spectrum sensing.

Text Books

- 1 Ethem Alpaydin, "Introduction to Machine Learning", 3e, MIT Press, 2014
- 2 Kevin P. Murphy, Machine Learning A probabilistic Perspective, MIT press, 2012
- 3 Machine Learning and Deep Learning Techniques in Wireless and Mobile Networking Systems (Big Data for Industry 4.0) by by K. Suganthi, R. Karthik, G. Rajesh, CRC Press; 1st edition, 2021.

Reference Books

- 1 Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006
- 2 T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer, 1st edition, 2001.
- 3 Luo, Fa-Long, ed. "Machine learning for future wireless communications." (2020).
- 4 Machine Learning and Cognitive Computing for Mobile Communications and Wireless Networks by Krishna Kant Singh, Akansha Singh, Wiley-Scrivener; 1st edition, 2020.
- 5 Applications of Machine Learning in Wireless Communications (Telecommunications) by by Ruisi He and Zhiguo Ding, Institution of Engineering and Technology, 2019.

Web Resources

1. https://onlinecourses.nptel.ac.in/noc16_cs18/
2. <http://freevideolectures.com/Course/2257/Machine-Learning> Online courses: 1 2
3. <https://www.coursera.org/learn/machine-learning> <https://www.edx.org/course/machine-learning-data-science-analyticscolumbiax-ds102x-0#>
4. <http://scikit-learn.org/stable/modules/clustering.html>
5. <https://towardsdatascience.com/k-means-clustering-algorithm-applications-evaluation-methods-and-drawbacks-aa03e644b48a>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
2	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
3	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
4	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1
5	2	1	1	-	-	-	-	-	-	-	-	2	2	-	1

Correlation Level: 1-Low, 2-Medium, 3-High

Course Objectives

- To learn basic Reality systems functions(operations)
- To design Virtual Reality considerations.
- To give knowledge of virtual environment hardware and software in virtual Reality applications
- To identify the concept of Augmented reality systems with its applications.
- To describe the Projector-based illumination and augmentation

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basic functioning of virtual Reality systems. **(K2)**

CO2 - Visualize the concepts of Geometric modelling and Geometrical Transformations. **(K2)**

CO3 - Learn Animated Virtual Environment, types of Hardware's and software's in virtual Reality systems **(K2)**

CO4 - Infer concept of Augmented reality systems with its applications. **(K2)**

CO5 - Describe the Projector-based illumination and augmentation with future displays. **(K2)**

UNIT - I INTRODUCTION

(9Hrs)

Virtual Reality & Virtual Environment: Introduction – Computer graphics – Real time computer graphics – Flight Simulation – Virtual environments –requirement – benefits of virtual reality- 3D Computer Graphics : Introduction – The Virtual world space – positioning the virtual observer – the perspective projection – Human vision – stereo perspective projection – 3D clipping – Color theory – Simple 3D modeling – Illumination models – Reflection models – Shading algorithms.

UNIT - II GEOMETRIC MODELING GEOMETRICAL TRANSFORMATIONS

(9Hrs)

Geometric Modeling: Introduction – From 2D to 3D – 3D space curves – 3D boundary representation - Geometrical Transformations: Introduction – Frames of reference – Modeling transformations – Instances – Picking – Flying – Scaling the VE – Collision detection - A Generic VR system: Introduction – The virtual environment- the Computer environment- VR Technology – Model of interaction- VR System.

UNIT – III VIRTUAL ENVIRONMENT

(9Hrs)

Animating the Virtual Environment: Introduction – The dynamics of numbers – Linear and Non-linear interpolation - The animation of objects – linear and non-linear translation - shape & object in between – freeform deformation – particle system- Physical Simulation : Introduction – Objects falling in a graphical field –Rotating wheels – Elastic collisions – projectiles – simple pendulum – springs – Flight dynamics of an aircraft. VR Hardware & Software- Modelling virtual world –Physical simulation- VR toolkits – Introduction to VRML

UNIT – IV AUGMENTED REALITY

(9Hrs)

Augmented Reality- Spatial Augmented Reality - Fundamentals: From Photons to Pixels - Augmented Reality Displays - Geometric Projection Concepts – Geometric Model - Rendering Framework - Calibration Goals - Display Environments and Applications.

UNIT – V PROJECTOR-BASED ILLUMINATION AND AUGMENTATION

(9Hrs)

Image-Based Illumination: Changing Surface Appearance - Creating Consistent Occlusion - Creating Consistent Illumination - Augmenting Optical Holograms - Augmenting Flat and Textured Surfaces - Augmenting Geometrically Non-Trivial Textured Surfaces - Spatial AR Displays -Augmented Paintings- Future Displays and Supporting Elements

Textbooks

1. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
2. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Inter science, India, 2003.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005
4. M. LaValle, "Virtual Reality, Steven", Cambridge University Press, 2016

Reference Books

- 1 Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
- 2 John Vince, "Virtual Reality Systems", Addison Wesley, 2012.
- 3 William R Sherman and Alan B Craig, "Understanding Virtual Reality: Interface, Application and Design (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002.
- 4 Doug A Bowman, Ernest Kujff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005

Web Resources

1. <https://digitaldefynd.com/best-augmented-reality-courses/>
2. <https://www.edx.org/learn/augmented-reality>
3. <https://www.classcentral.com/course/augmented-reality-virtual-reality-mixed--10508>
4. <https://nptel.ac.in/courses/106/106/106106138/>
5. <https://www.coursera.org/learn/introduction-virtual-reality>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	2	-	-	-	-	-	-	-	-	-	3	-	3
2	1	1	2	-	-	-	-	-	-	-	-	-	3	-	3
3	1	1	2	-	1	-	-	-	-	-	-	-	3	-	3
4	1	1	2	-	1	-	-	-	-	-	-	-	3	-	3
5	1	1	1	-	2	-	-	-	-	-	-	-	3	-	3

Correlation Level: 1-Low, 2-Medium, 3-High

Course Objectives

- To study the design concepts of low noise amplifiers.
- To learn various types of mixers designed for wireless communication.
- To design PLL and VCO.
- To acquire knowledge about various sub systems in wireless communication.
- To understand the concepts of CDMA in wireless communication.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Analyse the design concepts of low noise amplifiers. **(K4)**

CO2 - Differentiate various types of mixers designed for wireless Communication. **(K4)**

CO3 - Able to design PLL and VCO. **(K3)**

CO4 - Recognize various sub systems in wireless communication. **(K3)**

CO5 - Understand the concepts of CDMA in wireless communication. **(K2)**

UNIT - I COMPONENTS AND DEVICES**(9 Hrs)**

Introduction of wireless system -Integrated inductors, resistors, MOSFET and BJT Amplifier Design: Low Noise Amplifier Design - Wideband LNA - Design Narrowband LNA - Impedance Matching - Automatic Gain Control Amplifiers – Power Amplifiers

UNIT - II MIXERS**(9 Hrs)**

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion - Low Frequency Case: Analysis of Gilbert Mixer – Distortion - High-Frequency Case – Noise - A Complete Active Mixer. Switching Mixer - Distortion in Unbalanced Switching Mixer - Conversion Gain in Unbalanced Switching Mixer.

UNIT - III FREQUENCY SYNTHESIZERS**(9 Hrs)**

Phase Locked Loops - Voltage Controlled Oscillators - Phase Detector – Analog Phase Detectors – Digital Phase Detectors - Frequency Dividers - LC Oscillators - Ring Oscillators - Phase Noise - A Complete Synthesizer Design Example (DECT Application).

UNIT - IV SUB SYSTEMS**(9 Hrs)**

Analog-to-Digital Converters – Demodulators - A/D converters Used in a Receiver - Low-Pass Sigma-Delta Modulators - Band Pass Sigma-Delta Modulators - Implementation of Band Pass Sigma-Delta Modulators- I/Q mismatch in Mixer and A/D Converters - adaptive filters, Equalizers and transceivers.

UNIT - V IMPLEMENTATIONS**(9 Hrs)**

VLSI architecture for Multitier Wireless System - Hardware Design Issues for Next generation CDMA System

Text Books

1. B.Razavi, "RF Microelectronics", Prentice-Hall, 2012 second edition 2015
2. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2014.
3. Thomas H.Lee, "The Design of CMOS Radio –Frequency Integrated Circuits", Cambridge University Press, 2008. 2003
4. S.H.Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2016 1998
5. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge Press, 2005.

Reference Books

1. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI Wireless Design - Circuits and Systems", Kluwer Academic Publishers, 2000. (Paperback format 2013)
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 2012. (2nd edition 2016)

3. DALAL & UPENA, Wireless Communication, Oxford University Press, New Delhi, 2014.
4. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2007
5. Andreas Antoniou "Digital Filters" McGraw-Hill Science, 2000.

Web Resources

1. <http://www.wirelesscommunication.nl/reference/contents.htm>
2. https://www.tutorialspoint.com/wireless_communication.html
3. <http://www.nptelvideos.in/2012/12/wireless-communication.html>
4. <http://www.dsptechologie.com/products/specialist-semiconductors/high-reliability-integrated-circuits>
5. ece.ut.ac.ir/silab/research/vlsi_comm.htm

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	1	-	-	1	1	-	1	-	-	-
2	2	2	1	1	2	1	1	-	1	1	-	1	-	-	-
3	2	1	1	1	2	-	-	-	-	-	-	-	-	-	-
4	2	1	1	1	2	-	-	-	-	-	-	1	-	-	-
5	2	1	1	1	2	1	1	-	1	1	-	1	1	-	-

Correlation Level: 1-Low, 2-Medium, 3-High

U19ECE86

5G WIRELESS COMMUNICATION SYSTEMS

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- Learning the Basics of 5G and about 5G regulation protocol stack and its architecture.
- To understand the key technologies and enablers of 5G hardware technologies in 5G systems.
- To incorporate MIMO designs in 5G wireless systems analyze 5G wireless propagation channel models.
- To understand coordinated multi-point network architecture in 5G.
- To learn the new challenges in 5G modelling.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Map latest 5G Technology and its benefits with past technologies (K2)

CO2 - Learn the fundamentals of baseband and RF implementations in 5G using massive MIMO (K2)

CO3 - Attain knowledge about 5G Radio Access Technologies and its channel models (K3)

CO4 - Understand about 5G network architecture (K3)

CO5 - Implementation and evaluation of 5G and its applications (K4)

UNIT - I INTRODUCTION AND ROADMAP TO 5G

(9 Hrs)

Evolution of mobile technologies from 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G. Historical trend and evolution of LTE technology to beyond 4G – Key building blocks of 5G – 5G use cases and system concepts – The 5G Architecture – IoT: relation to 5G.

UNIT - II RF FRONT END FOR 5G

(9 Hrs)

Millimetre Wave Communications: Hardware technologies for mmW systems – Architecture and Mobility – Massive MIMO: Resource allocation and transceiver algorithms for massive MIMO - Fundamentals of baseband and RF implementations in massive MIMO – Beam forming.

UNIT - III 5G WAVEFORMS AND CHANNEL MODELS

(9 Hrs)

5G Radio Access Technologies: Design principles - Multi-carrier with filtering - Non-orthogonal Multiple Access - Radio access for dense deployments – Radio Access for V2X Communication - Radio access for massive machine-type communication - 5G wireless propagation channel models

UNIT - IV NETWORKING IN 5G

(9 Hrs)

Coordinated multi-point transmission in 5G: Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Buffer-aided relaying.

UNIT - V EVALUATION OF 5G AND 5G APPLICATIONS

(9 Hrs)

Machine-type communications: Fundamental techniques for MTC - Massive MTC - Ultra-reliable low-latency MTC - Device-to-device (D2D) communications - Multi-hop D2D communications - Multi-operator D2D communication - Simulation methodology: Evaluation methodology – Calibration - New challenges in the 5G modelling.

Text Books

1. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, - 5G Mobile Communications, Springer, 2017.
2. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, - 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.(Hardback format, 2019)
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", Taylor & Francis Inc, 2017

Reference Books

- 1 Jonathan rodriguez, - Fundamentals of 5G mobile networks, John Wiley & Sons, Ltd, 2015.
- 2 Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge,2011
- 3 University Press.D.R. Kamilo Feher Wireless Digital Communications, Prentice Hall of India, New Delhi.
- 4 Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications., 2014
- 5 Wong, Vincent WS, Robert Schober, Derrick Wing Kwan Ng, and Li-Chun Wang, eds. *Key technologies for 5G wireless systems*. Cambridge university press, 2017.

Web Resources

1. https://www.engineersgarage.com/article_page/5g-technology/
2. <https://www.techspot.com/guides/272-everything-about-5g/>
3. <https://pubmed.ncbi.nlm.nih.gov/27076701/>
4. [https://www.gsma.com › uploads › 2019/04 › The-5g](https://www.gsma.com/uploads/2019/04/The-5g)
5. <https://www.engpaper.com/5g-2018.htm>

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	-	-	-	-	-	-	-	-	2	1	-	1
2	2	1	1	-	-	-	-	-	-	-	-	2	1	-	1
3	2	1	2	-	-	-	-	-	-	-	-	2	2	-	1
4	2	1	2	-	-	-	-	-	-	-	-	2	2	-	2
5	2	1	2	-	-	-	-	-	-	-	-	2	3	-	3

Correlation L1 level: 1-Low, 2-Medium, 3-High

Course Objectives

- To know about basic of biomedical signal and its characteristics
- To learn about various signal conditioning circuits used in biomedical field
- To gain knowledge about basic measuring instruments in biomedical
- To study about the various assist devices used in the hospitals
- To understand recent trends in medical electronics

Course Outcomes

After completion of the course, the students will be able to

CO1 –Acquire the knowledge of basic of biomedical signal and various medical electrodes (K2)

CO2 – Gain the knowledge about various biomedical signal conditioning circuits (K3)

CO3 – Understand the working mechanism of basic bio signal measuring electronics instruments (K3)

CO4 – Interpret the various assist devices used in the hospitals viz. pacemakers, defibrillators, dialyzers and Ventilators (K3)

CO5 - Know about recent trends in medical electronics (K2)

UNT-I FUNDAMENTALS OF BIOMEDICAL ELECTRONICS**(9 Hrs)**

Sources of biomedical signals, Generalized medical instrumentation block diagram, Origin of bio potentials - characteristics – Frequency and amplitude ranges , Bio-potential electrodes, Types of electrodes - Surface; needle and micro electrodes, Medical electrode - ECG system, EEG electrode system, EMG, EOG, ERG-typical waveforms and signal characteristics.

UNIT-II BIO SIGNAL CONDITIONING CIRCUITS**(9 Hrs)**

Need for bio-amplifier – single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation – isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering.

UNIT-III CALIBRATION OF MEDICAL EQUIPMENT**(9 Hrs)**

Ventilator testers, SPO2analysers, NIBP analysers, Electro surgical analysers, Defibrillator analysers. Testing and maintenance of Heart lung machine, surgical lights, patient monitor, anaesthesia machine, dialyzer, surgical tools

UNIT-IV ASSISTING DEVICES**(9 Hrs)**

Blood pressure monitors – Electro-cardio scope - Pulse Oximeter - pH meter - Auto analyzer – Pacemakers – Defibrillator - Heart lung machine - Nerve and muscle stimulators - Dialysis machines - Surgical diathermy equipment – Nebulizer; inhalator - Aspirator – Humidifier - Ventilator and spirometry.

UNIT-V RECENT TRENDS IN MEDICAL ELECTRONICS**(9 Hrs)**

Digital radiography – CT - Basic Principle - Block diagram – Radioisotopes in medical diagnosis – Physics of radioactivity – Gamma Camera. Block diagram – SPECT Scanner – PET Scanner - Principles of NMR Imaging systems - Block diagram of NMR Imaging System – Ultrasonic Imaging Systems – Magnetic Resonance Imaging Systems.

Text Books

1. Leslie Cromwell, 'Biomedical Instrumentation and Measurement', Prentice Hall of India, New Delhi, second edition, 2014
2. R S Khandpur, "Handbook of Biomedical Instrumentation", 1st ed., Tata McGraw Hill Publishing Company Limited, 2014
3. Erich A. Pfeiffer, Fred J Weibell and Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice-Hall of India Pvt.Ltd, 2011

Reference Books

1. Khandpur, R.Stata, "Handbook of Biomedical Instrumentation", McGraw-Hill, New Delhi, 3rd edition 2014
2. John G.Webster, 'Medical Instrumentation Application and Design', 4th edition, Wiley India Edition, 2015
3. Joseph J.Carr and John M.Brown John, "Introduction to Biomedical Equipment Technology", Wiley and Sons, New York, 4th edition, 2001
4. Shakthi Chatterjee & Aubert Miller, "Biomedical Instrumentation", CENGAGE Learning, 2012
5. Chanderlekha Goswami, "Handbook of Biomedical Instrumentation", Manglam Publications, 2010

Web Resources

1. https://en.wikipedia.org/wiki/Biomedical_engineering
2. <https://guides.lib.uh.edu/biomedical>
3. https://www.google.co.in/books/edition/Handbook_of_Biomedical_Instrumentation
4. <https://nptel.ac.in/courses/108/108/108108180/>
5. <https://nptel.ac.in/courses/102/105/102105090/>

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COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	1	-	-	1	1	-	1	3	-	-
2	3	1	2	1	2	2	-	1	1	1	-	1	3	2	1
3	3	1	1	1	1	2	-	1	1	1	-	1	3	-	-
4	3	1	1	1	1	3	-	1	1	1	-	1	3	2	-
5	3	1	2	1	2	3	2	1	1	1	-	1	3	2	1

Correlation Level: 1-Low, 2-Medium, 3-High

Course Objectives

- To gain knowledge about fundamentals of image processing.
- To understand the various image segmentation techniques.
- To extract features for image analysis.
- To introduce the concepts of Video Analytic Components
- To illustrate 3D image visualization.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Explain the fundamentals of image processing **(K2)**

CO2 - Learn and Analyze various image segmentation techniques **(K2)**

CO3 - Understand extract features for image analysis. **(K2)**

CO4 - Develop knowledge about the concepts of image registration and image fusion. **(K3)**

CO5 - Identify 3D image visualization. **(K3)**

UNIT - I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING**(9 Hrs)**

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms- DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing

UNIT - II SEGMENTATION**(9 Hrs)**

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods.

UNIT - III FEATURE EXTRACTION**(9 Hrs)**

First and second order edge detection operators, Phase congruency, Localized feature extraction detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Run length features, Fractal model based features, Gabor filter, wavelet features.

UNIT - IV VIDEO ANALYTIC COMPONENTS**(9 Hrs)**

Need for Video Analytics-Overview of video Analytics. Foreground extraction- Feature extraction- classifier – Pre-processing- edge detection- smoothening- Feature space-PCA-FLD-SIFT features

UNIT - V 3D IMAGE VISUALIZATION**(9 Hrs)**

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

Text Books

- 1 Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2015
- 2 Ardeshir Goshtasby, " 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications", John Wiley and Sons, 2005.
- 3 John C.Russ, "The Image Processing Handbook", CRC Press 7th edition, Taylor & Francis Inc , 2015
- 4 Zhihao Chen (Author), Ye Yang , Jingyu Xue , Liping Ye, Feng Guo, The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video Analytics Suite, CreateSpace Independent Publishing Platform, 2014

Reference Books

- 1 Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", 2nd edition Academic Press, 2008.
- 2 R.C.Gonzalez and R.E. Woods, "Digital Image Processing ", 4th edition, Pearson, 2018
- 3 Rick S.Blum, Zheng Liu, "Multisensor image fusion and its Applications", Taylor& Francis, 2018.
4. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson Learning, 2013.
5. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill Education, 2009.

Web Resources

- 1 <http://eeweb.poly.edu/~onur/lectures/lectures.html>.
- 2 <http://www.caen.uiowa.edu/~dip/lecture/lecture.html>
- 3 <https://nptel.ac.in/courses/117105079/>
- 4 <https://nptel.ac.in/courses/108101113/>
- 5 <https://www.youtube.com/watch?v=GIL-h4IMgFk>

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
2	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
3	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
4	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1
5	3	1	2	-	-	-	-	-	-	-	-	-	3	-	1

Correlation L1 level: 1-Low, 2-Medium, 3-High