



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

SCHOOL OF ELECTRICAL AND ELECTRONICS

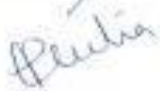
Minutes of Board of Studies Meeting held on 7th May 2022(Time: 10.30 a.m. to 12 noon)

- Dr.N.M.Nandhitha, Prof. & Dean School of Electrical and Electronics started the meeting by welcoming both the external and the internal members to the Board of Studies meeting (07.05.2022, 10.00 a.m. to 12.00 noon)
- Dr.T.Ravi, Head, Dept. of Electronics and Communication Engineering informed the board that core competencies are identified from the feedback obtained from the students, faculty, Alumni and employers.
Agenda : Syllabus submitted for suggestions and approval for the following courses (ECE) (syllabus revision for the existing courses and newly framed syllabus for the new courses)
- Dr.P.Kavipriya presented the revision carried out in the course Machine Learning Techniques. Dr.M.D.Selvaraj Associate Professor, IIITDM accepted the changes and suggested topics such as Occam learning, accuracy and confidence boosting.
- Dr.E.Annadevi suggested to introduce 'IoT in Logistics Sector' in the course IoT for Real Time Application. Dr.N.Sivakumaran Prof.,NIT, Tiruchy accepted the inclusion and also suggested to include Healthcare monitoring Technique for Diabetes Patients.
- Dr.P.Chitra suggested to include the topics 'Machine learning, Artificial neural networks and deep Architectures' in the course Digital Image Processing for Real Time Applications. Dr.N.Sivakumaran accepted the changes for both the courses.
- Dr.Anbarasi presented the revision carried out in the subject "Electromagnetic Interference and Compatibility" . Dr. Senthil Arunachalam suggested to include software and simulation topics in the course.
- Dr.Sugudev presented the syllabus revision carried in the course "Network Oriented OS". Mr.J.Visweswaran suggested to include the topic Securing web services in the syllabus.
- Having discussed the revisions in the existing courses, faculty then presented the syllabus for the new courses. Dr.T.Ravi presented the syllabus, 'Contemporary Wireless Communication', 'AI for Robotics', 'Engineering Projects in Community Service' and 'Industry 5.0 for Electronics Engineers' for UG courses. The new syllabus introduced for PG 'Artificial Intelligence for Industrial Applications' and Autonomous Drone Technology is also briefed by HOD. Dr.M.D.Selvaraj accepted the syllabus for all the courses.

BoS members are happy that the new and the revised courses enhance employability/ Entrepreneurship/Skills of the students.

The following internal members were present in the meeting.

Internal Members

1. Dr.N.M.Nandhitha 
2. Dr.T.Ravi 
3. Dr.M.Sumathy 
4. Dr.S.Lakshmi 
5. V.Vijaya Baskar 
6. Dr.P.Chitra 
7. Dr.P.Kavipriya 
8. Dr.S.Barani 
9. Dr.S.Poorna Pushpa Kala 
10. Dr.E.Annadevi 

External Members

Dr.N.Sivakumaran
Professor, Dept. of I & C
NIT, Trichy

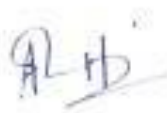


Dr.M.D.Selvaraj
Associate Professor
IIITDM, kancheepuram.

Mr.J.Visweswaran,
Academic Technical Consultant,
NI, Bangalore



Dr. Senthil Arunachalam ,
Director Automotive,
Jasmin Infotech Pvt. Ltd,
Chennai-119.





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School of Electrical & Electronics

Department of Electronics & Communication Engineering

1.1.2 Syllabus revision in 2022- 2023

SL.NO	COURSE CODE	COURSE NAME	FOCUSSED TOWARDS
1.	SEC1629	IoT for Real Time Applications	Skill Development
2.	SEC1630	Machine Learning Techniques	Skill Development
3.	SEC1628	Digital Image Processing for Real Time Application	Skill Development
4.	SECB7011	Electromagnetic Interference and Compatibility	Skill Development
5.	SECA7025	Network Oriented OS	Skill Development

SEC1629 (OLD)	IoT FOR REAL TIME APPLICATIONS	L	T	P	Credits	Total marks
		2	0	2	3	100
Pre requisite: NIL		Co Requisite: NIL				
Course Objectives • To design products related to IoT based Health care applications • To design IoT enable smart cities considering various energy harvesting techniques • To develop IoT based system for supporting farmers and agriculture • To develop IoT based system for industrial automation • To analyze various IoT based system considering societal benefits • To develop an IoT based wearable device for measuring physiological parameters and physical movements						
UNIT	CONTENTS					HOURS
I	IoT FOR HEALTHCARE Architecture of IoT for Healthcare , IoT based Health Monitoring System using Arduino, Smart continuous glucose monitoring (CGM) and insulin pens, Remote Patient Monitoring- IoT Heart Rate Monitoring, remote monitoring of physiological parameters, ECG, EEG, Diabetics and BP.					9
II	IoT ENABLED SMART CITIES Energy Consumption Monitoring, Smart Energy meters to minimize power consumptions, Smart home powered by IoT, Smart Grid and Solar Energy Harvesting, Intelligent Parking System					9
III	IoT FOR SMART AGRICULTURE Animal Intrusion detection in farms, soil moisture detection and Irrigation system, Pest monitoring and control, Livestock monitoring system, IoT based Greenhouse Environment Monitoring and controlling					9
IV	IoT BASED INDUSTRIAL AUTOMATION IoT based gas leakage monitoring system, Temperature and liquid level monitoring in boilers, Fire detection system, wireless video surveillance robot, Automatic Solar Tracker					9



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V	IoT FOR SOCIETY Medical Waste Management, Weather update system with IoT, Women security system, GPS Smart Sole , wearable glove to enable sign to speech conversation, IoT based air pollution meter	9
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Maximum Hours: 45

Course Outcomes

On completion of the course, the student should be able to

CO1 - Design remote data sensing and aggregation system for health care

CO2 - Develop energy efficient IoT systems for smart cities

CO3 – Design Precision agricultural systems

CO4 - Develop smart automation system for Industries

CO5 - Investigate various IoT based innovative systems for societal benefits

CO6 - Develop multipurpose wearable devices



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SECA3027 REVISED	IoT FOR REAL TIME APPLICATIONS	L	T	P	Credits	Total marks
		2	0	2	3	100
Pre requisite: NIL		Co Requisite: NIL				
Course Objectives ● To design products related to IoT based Health care applications ● To design IoT enable smart cities considering various energy harvesting techniques ● To develop IoT based system for supporting farmers and agriculture ● To develop IoT based system for industrial automation ● To analyze various IoT based system considering societal benefits ● To develop an IoT based wearable device for measuring physiological parameters and physical movements						
UNIT	CONTENTS					HOURS
I	IoT FOR HEALTHCARE Architecture of IoT for Healthcare , IoT based Health Monitoring System using Arduino, Healthcare monitoring Technique for Diabetes Patients, Remote Patient Monitoring- IoT Heart Rate Monitoring, remote monitoring of physiological parameters, ECG, EEG, and BP.					9
II	IoT ENABLED SMART CITIES Smart Energy meters, , , Smart home powered by IoT, Smart Lightning, Smart Traffic Control ,Smart Grid and Solar Energy Harvesting, Intelligent Parking System.					9
III	IoT FOR SMART AGRICULTURE Smart Agriculture, IoT Based Agriculture,Animal Intrusion detection in farms, soil moisture detection and Irrigation system, Livestock monitoring system, IoT based Greenhouse Environment Monitoring and controlling					9
IV	IoT BASED INDUSTRIAL AUTOMATION IoT based gas leakage monitoring system, Temperature and liquid level monitoring in boilers, Wireless video surveillance robot, Automatic Solar Tracker, IoT in Logistics Sector					9
V	IoT FOR SOCIETY Medical Waste Management, Weather update system with IoT, Women security system,wearable glove to enable sign to speech conversation, IoT based air pollution meter, Improved productivity of staff and reduced human labor					9



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Course Outcomes

On completion of the course, the student should be able to

CO1 - Design remote data sensing and aggregation system for health care

CO2 - Develop energy efficient IoT systems for smart cities

CO3 – Design Precision agricultural systems

CO4 - Develop smart automation system for Industries

CO5 - Investigate various IoT based innovative systems for societal benefits

CO6 - Develop multipurpose wearable devices

TEXT / REFERENCE BOOKS

1. Fadi Al-Turjman, Intelligence in IoT- enabled Smart Cities, 2019, 1st edition, CRC Press, ISBN-10: 1138316849
2. Giacomo Veneri, and Antonio Capasso, Hands-on Industrial Internet of Things: Create a powerful industrial IoT infrastructure using Industry 4.0, 2018, Packt Publishing.
3. Krishna P. Venkata, Sasikumar Gurumoorthy, Mohammad S.Obaidat, Internet of Things and Personalized Healthcare Systems , Springer-2019.
4. Pattnaik, Prasant Kumar, Mohanty, Suneeta, Mohanty, Satarupa, Smart Healthcare Analytics in IoT Enabled Environment, Springer-2020.
5. Avijit Mathur, Thomas Newe, Walid Elgenaidi, Muzaffar Rao, Elfed Lewis and Daniel Toal, Medical IoT systems: architecture and security by Wearable Sensors, 2017.
6. Verónica Saiz-Rubio , Francisco Rovira-Mas ,From Smart Farming towards Agriculture 5.0: A Review on Crop Data Management, Agronomy 2020, 10, 207; doi:10.3390/ agronomy 10020207



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SEC1630 (OLD)	MACHINE LEARNING TECHNIQUES	L	T	P	Credits	Total marks
		2	0	2	3	100
Pre Requisite: NIL		Co Requisite: NIL				
Course Objectives ● To Recognize Different Key Paradigms For Machine Learning Concepts ● To Familiarize With Various Classifiers Used For Machine Learning ● To Understand And Differentiate Among Various Supervised Learning Concepts ● To Become Familiarize With Data Reduction And Feature Extraction Methods ● To Apply Suitable Machine Learning Algorithms For Simple Engineering Problems						
UNIT	CONTENTS					HOURS
I	INTRODUCTION TO MACHINE LEARNING Machine Learning vs Statistical Modelling, Applications of Machine Learning, Supervised vs Unsupervised Learning, Supervised Learning Classification, Unsupervised Learning Classification, Python libraries suitable for Machine Learning.					9
II	CLASSIFIERS Classification, K- nearest neighbour, Decision Trees, Implementing Decision Tree, building a Tree, Random Forests - Working of Random Forest, Pros and Cons of Random Forest, Naiver Bayes, building model Using Naiver Bayes					9
III	SUPERVISED LEARNING Regression, Types of Regression model, Building a Regressor in Python, Types of ML Algorithm, Linear Regression, Multiple Linear Regression, Non-linear Regression, Model evaluation methods.					9
IV	K-MEANS CLUSTERING Working of K-Means Clustering Algorithm, Advantages and Disadvantages, Applications of K-Means Clustering Algorithm, Hierarchical Clustering, Steps to Perform Agglomerative Hierarchical Clustering, Role of Dendrograms Agglomerative Hierarchical Clustering, Density-Based Clustering.					9
V	DIMENSIONALITY REDUCTIONS & COLLABORATIVE FILTERING Dimensionality Reduction, Feature Extraction & Selection, Linear Discriminant Analysis, Principal Component Analysis, Factor Analysis, Independent Component Analysis, Locally Linear Embedding, Least Squares Optimization, Collaborative Filtering & Its Challenges.					9



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Course Outcomes

On completion of the course, student should be able to

CO 1 - Classify supervised and unsupervised learning

CO 2 - Apply appropriate machine learning strategies for any given problem

CO 3 - Recommend supervised and unsupervised learning algorithms for any given problem

CO 4 - Apply the Bayesian concepts to machine learning

CO 5 – Evaluate existing machine learning algorithms

CO 6 - Develop an appropriate machine learning approach for Real World Problems

TEXT / REFERENCE BOOKS

1. Chris Albon : Machine Learning with Python Cookbook , O'Reilly Media, Inc.2018
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014
3. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education
4. Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012
5. EthemAlpaydin, Introduction to machine learning, second edition, MIT press.
6. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer Series , 2nd edition
7. Sebastian Raschka, "Python Machine Learning",Second Edition.Packt Publication



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SECA3028 (Revised)	MACHINE LEARNING TECHNIQUES	L	T	P	Credits	Total marks
		2	0	2	3	100
Pre Requisite: NIL			Co Requisite: NIL			
Course Objectives ● To Recognize Different Key Paradigms For Machine Learning Concepts ● To Familiarize With Various Classifiers Used For Machine Learning ● To Understand And Differentiate Among Various Supervised Learning Concepts ● To Become Familiarize With Data Reduction And Feature Extraction Methods ● To Apply Suitable Machine Learning Algorithms For Simple Engineering Problems						
UNIT	CONTENTS					HOURS
I	INTRODUCTION TO MACHINE LEARNING Machine Learning vs Statistical Modelling, Applications of Machine Learning, Supervised vs Unsupervised Learning, Supervised Learning Classification, Unsupervised Learning Classification, Python libraries suitable for Machine Learning.					9
II	CLASSIFIERS Classification, K- nearest neighbour, Decision Trees, Implementing Decision Tree, building a Tree, Random Forests - Working of Random Forest, Pros and Cons of Random Forest, Naiver Bayes, building model Using Naiver Bayes					9
III	SUPERVISED LEARNING Regression, Types of Regression model, Building a Regressor in Python, Types of ML Algorithm, Linear Regression, Multiple Linear Regression, Non-linear Regression, Model evaluation methods.					9
IV	K-MEANS CLUSTERING Working of K-Means Clustering Algorithm, Advantages and Disadvantages, Applications of K-Means Clustering Algorithm, Hierarchical Clustering, Steps to Perform Agglomerative Hierarchical Clustering, Role of Dendrograms Agglomerative Hierarchical Clustering, Density-Based Clustering.					9
V	ML- Models and Computational Learning Parameter Estimation, sufficient statistics, decision trees, neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, probabilistic relational models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers. Computational Learning theory, mistake bound analysis, sample complexity analysis, VC dimension, Occam learning,					9



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	accuracy and confidence boosting	
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Maximum Hours: 45

Course Outcomes

On completion of the course, student should be able to

CO 1 - Classify supervised and unsupervised learning

CO 2 - Apply appropriate machine learning strategies for any given problem

CO 3 - Recommend supervised and unsupervised learning algorithms for any given problem

CO 4 - Apply the Bayesian concepts to machine learning

CO 5 – Evaluate existing machine learning algorithms

CO 6 - Develop an appropriate machine learning approach for Real World Problems

TEXT / REFERENCE BOOKS

1. Chris Albon : Machine Learning with Python Cookbook , O'Reilly Media, Inc.2018
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014
3. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education
4. Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012
5. EthemAlpaydın, Introduction to machine learning, second edition, MIT press.
6. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer Series , 2nd edition
7. Sebastian Raschka, "Python Machine Learning",Second Edition.Packt Publication



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SEC1628 (old)	DIGITAL IMAGE PROCESSING FOR REAL TIME APPLICATION	L	T	P	Credit s	Total mark s
		2	0	2		
Pre requisite: NIL			Co Requisite: NIL			
Course Objectives • To explore the fundamental concepts of Image Processing • To become conversant with various Image Enhancement techniques • To study and understand various Morphological and segmentation concepts and techniques • To analysis the pattern classifier techniques for image understanding • To design Artificial Intelligence (AI) based image classification and object detection systems						
UNIT	CONTENTS					HOURS
I	DIGITAL IMAGE FUNDAMENTALS Image acquisition and storage; Basic Relationships between Pixels; Monochromatic Vision Models; Colour Vision Models; Colour Fundamentals; Colour Models; Image resizing; Image noise- additive and multiplicative noises; Image quality indicators (Quality Metrics)- PSNR, SSIM, VIF, accuracy, Correlation. Case study: Develop a software program to measure the quality of the given image.					9
II	IMAGE ENHANCEMENT Introduction; Point Processing - Image Negatives, Log transformations, Power Law Transformations, Piecewise-Linear Transformation Functions; Arithmetic/Logic Operations - Image Subtraction, Image Averaging; Histogram Processing - Histogram Equalization, Histogram Matching; Spatial filtering - Smoothing, Sharpening; Smoothing Frequency Domain Filters - Ideal Low Pass, Butterworth Low Pass, Gaussian Low Pass; Sharpening Frequency Domain Filters - Ideal High Pass, Butterworth High Pass, Gaussian High Pass; Image denoising- Wavelet Transform(DWT), Case study: Develop a program for the image denoising using DWT.					9
III	MORPHOLOGICAL PROCESSING & SEGMENTATION Morphological Image Processing - Logic Operations involving Binary Images; Dilation and Erosion; Opening and Closing; Basic Morphological Algorithms - Boundary Extraction, Region Filling, Thickening, Thinning; Image Segmentation - Detection of Discontinuities; Edge Linking; Boundary Detection; Thresholding - Global and Adaptive; Region based Segmentation, Case study: Develop a program for segmentation of an objects from the background and transfer them from one image to another.					9



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IV	PATTERN CLASSIFIER Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation– Problems with Bayes approach– Pattern classification by distance functions –Minimum distance pattern classifier, Template matching – probabilistic approach- K-nearest neighbour (KNN), Path Forest- Fuzzy logic – Fuzzy Pattern Classifiers, Case study: Fuzzy clustering algorithm.	9
V	AI IN IMAGE PROCESSING Design and execute image classification, object recognition, object detection and object localization systems using machine learning, deep learning and transfer learning techniques.	9

Maximum Hours:
45

Course Outcomes

On completion of the course, the student will be able to

CO1- Apply Suitable Mathematical Concepts For The Measurement Of Quality In Digital Images.

CO2-Analyze The Performance Of Spatial And Frequency Domain Filters In Image Enhancement.

CO3-Analyze Various Morphological Image Processing And Segmentation Techniques

CO4-Identify Suitable Pattern Classifier For Object Classification Problems.

CO5-Implement Ai Based Image Classification And Object Detection Systems.

CO6-Solve Real World Problems Using AI

TEXT / REFERENCE BOOKS

1. Rafael C. Gonzalez, Richard E. Woods,” Digital Image Processing”, Pearson , Second Edition, 2004
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson 2002
3. Robert J.Schalkoff, “Pattern Recognition Statistical, Structural and Neural Approaches”,John Wiley & Sons Inc., New York, 1992
4. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, John Wiley, 2001
5. Himanshu Singh. “Practical Machine Learning and Image Processing”, Apress, 2019
6. Francois Chollet “Deep Learning with Python”, Manning Publications Co., NY, 2018
7. Phil Kim. “MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence”,
8. Apress, 2017.

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9. Artificial Intelligence in Recognition and Classification of Astrophysical and Medical Images
10. Valentina Zharkova, Lakhmi C. Jain, "Artificial Intelligence in Recognition and Classification of Astrophysical and Medical Images", Springer, 2007



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SECA3030 (Revised)	DIGITAL IMAGE PROCESSING FOR REAL TIME APPLICATIONS	L	T	P	Credit s	Total mark s
		2	0	2		
Pre requisite: NIL			Co Requisite: NIL			
Course Objectives ● To explore the fundamental concepts of Image Processing ● To become conversant with various Image Enhancement and restoration techniques ● To study and understand various Morphological and segmentation concepts and techniques ● To analysis the pattern classifier techniques for image understanding ● To design Artificial Intelligence (AI) based image classification systems						
UNIT	CONTENTS					HOURS
I	DIGITAL IMAGE FUNDAMENTALS Image acquisition and storage; Basic Relationships between Pixels; Monochromatic Vision Models; Colour Vision Models; Colour Fundamentals; Colour Models; Image resizing; Image noise- additive and multiplicative noises; Image quality indicators (Quality Metrics)- PSNR, SSIM, VIF, accuracy, Correlation. Case study: Develop a software program to measure the quality of the given image.					9
II	IMAGE ENHANCEMENT AND IMAGE RESTORATION Histogram Matching Introduction; Point Processing - Image Negatives, Log transformations, Power Law Transformations, Piecewise-Linear Transformation Functions; Arithmetic/Logic Operations - Image Subtraction, Image Averaging; Histogram Processing - Histogram Equalization,; Spatial filtering - Smoothing, Sharpening; Wavelet Transform(DWT), Introduction to Image restoration, Image degradation, Types of image blur, Classification of image restoration techniques, Image restoration model, Linear and Nonlinear image restoration techniques, Case study: Develop a program for the image denoising using DWT.					9



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III	MORPHOLOGICAL PROCESSING & SEGMENTATION Morphological Image Processing - Logic Operations involving Binary Images; Dilation and Erosion; Opening and Closing; Basic Morphological Algorithms - Boundary Extraction, Region Filling, Thickening, Thinning; Image Segmentation - Detection of Discontinuities; Edge Linking; Boundary Detection; Thresholding - Global and Adaptive; Region based Segmentation, Case study: Develop a program for segmentation of an objects from the background and transfer them from one image to another.	9
IV	PATTERN CLASSIFIER Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation– Problems with Bayes approach– Pattern classification by distance functions –Minimum distance pattern classifier, Template matching - probabilistic approach- K-nearest neighbour (KNN), Path Forest- Fuzzy logic – Fuzzy Pattern Classifiers, Case study: Fuzzy clustering algorithm.	9
V	AI IN IMAGE PROCESSING Image processing with machine Learning-machine learning workflow for image processing- Introduction to software tools for image processing and machine learning-Artificial neural networks, deep architectures. Design and execute image classification using machine learning and deep learning techniques.	9

Maximum Hours:
45

Course Outcomes

On completion of the course, the student will be able to

CO1- Apply Suitable Mathematical Concepts For The Measurement Of Quality In Digital Images.

CO2-Analyze the Performance of Image enhancement and image restoration techniques.

CO3-Analyze Various Morphological Image Processing and Segmentation Techniques.

CO4-Identify Suitable Pattern Classifier for Object Classification Problems.

CO5-Implement AI Based Image Classification Systems.

CO6-Solve Real World Problems Using AI

TEXT / REFERENCE BOOKS

1. Rafael C. Gonzalez, Richard E. Woods," Digital Image Processing", Pearson , Second Edition, 2004
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson 2002
3. Robert J.Schalkoff, "Pattern Recognition Statistical, Structural and Neural Approaches",John Wiley & Sons Inc., New York, 1992
4. R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2001



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5. Himanshu Singh. "Practical Machine Learning and Image Processing", Apress, 2019
6. Francois Chollet "Deep Learning with Python", Manning Publications Co., NY, 2018
7. Phil Kim. "MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence",
8. Apress, 2017.
9. Artificial Intelligence in Recognition and Classification of Astrophysical and Medical Images
10. Valentina Zharkova, Lakhmi C. Jain, "Artificial Intelligence in Recognition and Classification of Astrophysical and Medical Images", Springer, 2007



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SECB7011 (OLD)	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	Cred its	Total Marks
		3	0	0	3	100

Pre requisite: Nil

Co requisite: Nil

COURSE OBJECTIVES

- To provide an understanding of Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC) methodology and concepts.
- To become familiar with specifications, standards and measurements of EMI.
- To learn EMI filter design and other mitigating solutions.
- To understand circuit board layout and mechanical packaging considerations for EMI/EMC compliant designs.

UNIT 1 EMI ENVIRONMENT

9 Hrs.

Introduction to EMI/EMC-Basics of electro Magnetic interference (EMI) Fundamentals of electromagnetic compatibility (EMC)-Radiation hazards Transients and other EMI sources Electrostatics discharge (ESD) Phenomena and effects, Transient phenomena and suppression -Tempest- Lightning.

UNIT 2 EMI COUPLING

9 Hrs.

EMI coupling modes - CM and DM -EMI from apparatus and circuits: Introduction-Electromagnetic emission-Appliances- noise from relays and switches-nonlinearities in circuits-Passive inter modulation-Cross talk in transmission lines - **Transmission in power supply lines** - **Electromagnetic interference.**

UNIT 3 EMI SPECIFICATION / STANDARDS AND MEASUREMENTS

9 Hrs.

Units of specification - civilian standards and military standards. Basics of EMI measurements-EMI measurement tools-TEM cell-measurement using TEM cell-Reverberating chamber-GTEM cell-Anechoic chamber-Open area test site-RF absorbers- conducted interference measurements-conducted EMI from equipment - **Experimental setup for measuring conducted EMI- Measurement of DM interferences.**

UNIT 4 EMI CONTROL TECHNIQUES

9 Hrs.

Shielding technique-Filter techniques-Grounding techniques-Bonding techniques-Cable connectors and components- Isolation transformer-Transient suppressor- EMI gasket- Opto-Isolator.

UNIT 5 EMC DESIGN OF PCB

9 Hrs.

Designing for EMC: Introduction - Different techniques involved in designing for EMC-EMC guide lines for PCB designs- EMC design guide line for audio and control circuit design, RF design, power supply design-Mother board designs and propagation delay- Trace routing, Impedance control, decoupling, Zoning and grounding

Max. 45 Hrs.

COURSE OUTCOMES



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On completion of the course, students are able to

- CO1 - Analyse the effect of radiation hazards from RF equipment.
- CO2 - Evaluate the level of noise interference from electrical appliances.
- CO3 - Apply different EMI control techniques in the design of RF systems.
- CO4 - Analyse the protocols set by IEEE standards for EMI/EMC.
- CO5 - Apply appropriate EMI measurement techniques for product validation.
- CO6 - Apply EMC guidelines in the design of printed circuit boards for various applications.

TEXT / REFERENCE BOOKS

- [1] Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2016.
- [2] V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, Newyork, 2011.
- [3] Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, Newyork, 2013.
- [4] Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2012.
- [5] Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2010.



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SECB7027 (REVISED)	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	Cred its	Total Marks
		3	0	0		

Pre requisite: Nil

Co requisite: Nil

COURSE OBJECTIVES

- To provide an understanding of Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC) methodology and concepts.
- To become familiar with specifications, standards and measurements of EMI.
- To learn EMI filter design and other mitigating solutions.
- To understand circuit board layout and mechanical packaging considerations for EMI/EMC compliant designs.

UNIT 1 EMI ENVIRONMENT

9 Hrs.

Introduction to EMI/EMC-Basics of electro Magnetic interference (EMI) Fundamentals of electromagnetic compatibility (EMC)-Radiation hazards Transients and other EMI sources Electrostatics discharge (ESD) Phenomena and effects, Transient phenomena and suppression -Tempest- Lightning.

UNIT 2 EMI COUPLING

9 Hrs.

EMI coupling modes - CM and DM -EMI from apparatus and circuits: Introduction-Electromagnetic emission-Appliances- noise from relays and switches-nonlinearities in circuits-Passive inter modulation-Cross talk in transmission lines.

UNIT 3 EMI SPECIFICATION / STANDARDS AND MEASUREMENTS

9 Hrs.

Basics of EMI measurements-EMI measurement tools-TEM cell-measurement using TEM cell-Reverberating chamber-GTEM cell-Anechoic chamber-Open area test site-RF absorbers-conducted interference measurements-conducted EMI from equipment

UNIT 4 EMI CONTROL TECHNIQUES

9 Hrs.

Shielding technique-Filter techniques-Grounding techniques-Bonding techniques-Cable connectors and components- Isolation transformer-Transient suppressor- EMI gasket- Opto-Isolator.

UNIT 5 SOFTWARE TOOLS FOR EMI AND EMC

9 Hrs.

Introduction to Ansys SIwave Software - Modeling high-speed channels and Power delivery systems for high-performance electronics board- Verification of noise margins and impedance profiles - Automatic decoupling analysis in low-voltage designs.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students are able to

- CO1 - Analyse the effect of radiation hazards from RF equipment.
- CO2 - Evaluate the level of noise interference from electrical appliances.
- CO3 - Apply different EMI control techniques in the design of RF systems.
- CO4 - Analyse the protocols set by IEEE standards for EMI/EMC.



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- CO5 - Apply appropriate EMI measurement techniques for product validation.
- CO6 - Analyse EMC/EMI aspects using Ansys Slwave Toolkit in high performance electronics boards.

TEXT / REFERENCE BOOKS

- [1] Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2016.
- [2] V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, Newyork, 2011.
- [3] Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, Newyork, 2013.
- [4] Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & TechnologyBooks, 2012.



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SECA7037	NETWORK ORIENTED OS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce students to the state of the art in wireless sensor actuator networks.
- To provide hands on training in programming these networks and several applications such as environmental monitoring, perimeter security, structural control, asset tracking and personal health care systems.
- To introduce students to network oriented operating systems.

UNIT 1 OVERVIEW OF IOT CONTIKI OS

9Hrs.

Need for light weight operating systems for IoT - Open Source Operating Systems for IoT- Basic introduction to Contiki OS: Basic operations, proto-threads, timers, event management -Contiki Communication components: MicroIP, ,uIPV6 and RIME, 6LoWPAN

UNIT 2 COOJA SIMULATOR AND 6LOWPAN

9Hrs.

Introduction to the Cooja emulator. Introduction to 6LoWPAN.6LoWPAN architecture: simple, extended and ad-hoc networks. Issues in determining IPv6 links in LLNs and illustration of the undetermined link addressing model-IPv6 addressing in 6LoWPAN. 6LoWPAN forwarding: route-over and mesh under approaches.

UNIT 3 ROUTING IN LOSSY NETWORK

9Hrs.

Heterogeneous Traffic Networks - Introduction to RPL - IPv6 Routing Protocol for Low power networks - Multi-point to point routing with destination oriented directed acyclic graphs.

UNIT 4 RPL CONSTRAINT AND CONFIGURATION

9Hrs.

RPL instances, routing metrics and constraints - Introduce 6LBR - RPL protocol configuration in Contiki - Overview of the general configuration parameters.

UNIT 5 APPLICATIONS OF NETWORK OPERATING SYSTEMS

9Hrs.

Deploying a file server – Using File serves role – Deploying print server – Securing web services – Configuring terminal services clients and gateways.

Max. 45Hrs.

COURSE OUTCOMES



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Added content

On completion of the course, student will be able to

CO1 - Identify suitable light weight operating system for a specific IoT based applications.

CO2 - Apply right IoT communication stack for given application requirements.

CO3 - Develop IoT applications using Contiki Operating System.

CO4 - Design a Low power PAN and analyze its performance using Cooja emulator.

CO5 - Analyze the performance of various routing protocols for low power and lossy wireless sensor networks.

CO6 - Implement network applications using network operating systems.

TEXT / REFERENCE BOOKS

1. Agus Kurniawan, “ Practical Contiki-NG: Programming for Wireless Sensor Networks”, Apress; 1st ed. Edition, 2018.
2. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Network”, Wiley, 1st Edition, 2007. ISBN:978-0-471-74300-2.
3. C.Siva Ram Murthy and B.S.Manoj “AdHoc Wireless Networks :Architectures and Protocols”, Prentice Hall, 1st Edition, 2004.
4. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education, 6th Edition, 2016.
5. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, Wiley, 1st Edition, 2007.
6. Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Morgan Kaufmann, 1st Edition, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Exam Duration: 3 Hrs.

PART A: 5 Questions of 6 Marks each – No choice

30 Marks

PART B: 2 Questions from each unit of internal choice, each carrying 14 Marks

70 Marks



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Added content



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School of Electrical & Electronics

Department of Electronics & Communication Engineering

New Courses Introduced in 2022- 2023

CONTENTS

S. No.	Course Code	Course Name
1	SECA1704	Contemporary Wireless Communication
2	S13AEPICS	Engineering Projects in Community Service
3	SECA3032	AI in Robotics
4	SECA7041	Artificial Intelligence for Industrial Applications
5	SECA1404	Industry 5.0 for Electronics Engineers
6	SECA7043	Autonomous Drone Technology

SECA1704	CONTEMPORARY WIRELESS COMMUNICATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge on evolution of mobile communication and standards.
- To understand current trends in wireless LAN protocols.
- To study about personal area network and M2M communication standards.
- To impart knowledge on role of satellites in mobile and internet services.
- To study about underwater wireless communication techniques.

UNIT 1 EVOLUTION OF CELLULAR MOBILE NETWORKS

9hrs

UMTS and CDMA 2000 (3G) - Wideband CDMA (WCDMA) - LTE and LTE advanced (4G) - Network architecture – Modulation – Coding schemes – 5G systems: specifications and applications.

UNIT 2 WIRELESS LAN STANDARDS

9 hrs

IEEE 802 Standards – IEEE 802.11 WLAN Standards – Comparison of IEEE 802.11 a, b and g standards, Wi-Fi-5 and WiGig - Concepts of MIMO, Massive MIMO and MU MIMO -Principle of Li-Fi based WLAN.

UNIT 3 PERSONAL AREA NETWORK PROTOCOLS

9 hrs

Bluetooth -Piconet, Scatternet- Bluetooth Low Energy(BLE) - Zig-Bee- Z-wave – UWB- LoRA Wireless Standards, LoRA WAN Gateway, LORA Applications.

UNIT 4 SATELLITE MOBILE AND SPECIALIZED SERVICES

9 hrs

Types of Satellites – LEO, MEO and GEO – Satellite services in Cellular Mobile communication - Satellite Phones – Satellite IoT services - Satellite Internet Service: Starlink and Viasat – GPS Services: GLONASS, IRNSS and NAVIC.

UNIT 5 UNDERWATER WIRELESS COMMUNICATION

9 hrs

Underwater Communication: IEEE Standards, Modulation techniques, Frequency Spectrum, Modulation Techniques - Underwater Channel models for wireless Communication – Role of Digital signal processing in Underwater Communication- Underwater localization

Max. 45 hrs

COURSE OUTCOMES:

On completion of this course, students are able to

CO1	Classify various generations of wireless communication and standards
CO2	Demonstrate the applications of different international standards in wireless LAN and PAN
CO3	Develop an energy efficient system level model for IoT applications
CO4	Appraise and report on advances in higher generations of wireless communication systems.
CO5	Design conceptually a mobile communication system according to the required standard.
CO6	Develop system level models for underwater communication.



TEXT / REFERENCE BOOKS:

- [1] William C.Y. Lee., "Wireless and Cellular Telecommunications", 3rd Edition revised reprint McGraw Hill.2011.
- [2] Iti saha Mishra , "Wireless Communications and Networks: 3G and Beyond" 2nd Edition McGraw Hill 2013.
- [3] Nishith D. Tripathi and Jeffrey H. Reed,"Cellular Communications A Comprehensive and Practical Guide" Wiley 2014.
- [4] Rajpandya " Mobile and Personal Communication Services and Systems", IEEE Inc., New York, 2014.
- [5] Nitin Goyal, Luxmi Sapra, Jasminder Kaur Sandhu," Energy-Efficient Underwater Wireless Communications and Networking", 1st Edition, Business Science Reference , 2020

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Exam Duration: 3 hrs

Part A: 10 questions of 2 marks each -No choice

20 Marks

Part B: 5 questions from each unit with internal choice, each carrying 16 marks

80 Marks



S13AEPICS	Engineering Projects in Community Service	L	T	P	Credits	Total marks
						100

Course Objectives

To Properly define and scope a problem; To Identify and analyze relevant factors;

To apply appropriate industrial engineering methodologies and computational tools; To Generate and evaluate alternative solutions;

To Improve skills in

- Technical writing, ▪ Public speaking, ▪ Working within a team (when applicable), and ▪ Project and time management.

Unit I	Multidisciplinary Design: Learn how to be better designers, gain design knowledge and skills; learn how to apply disciplinary knowledge to real and possibly ill-defined problems; learn how to identify and acquire new knowledge; learn to collaborate with people from other disciplines and develop an appreciation for cross-disciplinary contributions in design.	9hrs
Unit II	Professional Preparation: Develop the broad set of skills needed to be successful in the changing global workplace and world:	9hrs
Unit III	Service-Learning: Provide significant service to the community while learning; gain an understanding of the role that engineering (and their discipline) can play in society and the broader issues related to the needs we are addressing.	9hrs
Unit IV	Case studies on community service	9hrs
Unit V	Identification of engineering solutions to a real world problem	9hrs

The students will be able

CO1: To investigate the real -world problems

CO 2: To illustrate the real -world problems with community service

CO 3: To demonstrate design the solutions using multi- disciplinary approach

CO 4: To investigate the processes

CO 5: To analyze the solutions given

CO 6: To develop empathy



SECA3032	AI in ROBOTICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- The objective of this course is to impart knowledge about robots with respect to its control and design.
- To simulate robots with artificial intelligence techniques and implement it for specific applications

UNIT 1 Introduction to Robotics

9 Hrs

Basics of robotics, Classification and components of a robot, Links and joints, Laws of robotics, Configurations of robot, work volume, spatial resolution, repeatability of a robot, speed of motion, load carrying capacity, Robot wrist, Drive systems of robot, Sensors and actuators used in robots, Power transmission system used in robots.

UNIT 2 Robot Kinematics and Dynamics

9 Hrs

Robot Kinematics: Position analysis, Dynamic analysis and forces, Translation and Rotation representation, Coordinate transformation, D-H parameters, Requirements of a robot programming language, problems peculiar to robot programming languages, three levels of robot programming.

UNIT 3 Problem solving and Scope of AI

9Hrs

Introduction to Artificial Intelligence, Applications: Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems. AI techniques: search knowledge, abstraction.

Problem Solving: State space search: Production systems, search space control: depth-first, breadth-first search. Heuristic search - Hill climbing, best-first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means-End Analysis. LA* Algorithm, L(AO*) Algorithm.

UNIT 4 Knowledge Representation

9Hrs

Knowledge Representation issues, first order predicate calculus, Horn Clauses, Resolution, Semantic Nets, Frames, Partitioned Nets, Procedural Vs Declarative knowledge, Forward Vs Backward Reasoning.

UNIT 5 Applications of AI in Robotics

9Hrs

Introduction to NLP, Basics of Syntactic Processing, Semantic Analysis and Parsing techniques, context free and transformational grammars, transition nets, augmented transition nets, Concept of learning, learning automation, learning by inductions and neural nets

Introduction to programming languages, LISP and PROLOG, leading role of NLP in Robotic Process Automation with farming robots, navigation robots and automobile manufacturing robots.

COURSE OUTCOMES

On completion of the course the student will be able to

- CO1:** Perform kinematic and dynamic analyses of robots with simulation.
- CO2:** Implement AI techniques in robotics.
- CO3:** Analyze various AI techniques for game console, problem solving.
- CO4:** Create a robotic system with dynamic programming approach.
- CO5:** Create a robotic system with syntactic and semantic processing.



TEXT/REFERENCE BOOKS

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
3. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, "Robotic Engineering - An integrated approach", PHI Publication, 1993
4. John J. Craig, "Introduction to Robotics", Addison Wesley Publication, 1989.
5. M. Sasikumar, S. Ramani, "A Practical Introduction to Rule Based Expert Systems", Narosa Publishing House, 1994
6. Elaine Rich and Kevin Knight, "Artificial intelligence", Tata McGraw Hill Pub., 2nd ed., 1992.
7. N.J. Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, 1990.
8. Robert.J. Schalkoff, "Artificial Intelligence - an Engineering Approach", McGraw Hill Int. Ed., Singapore, 1992.



SECA7041	Artificial Intelligence for Industrial Applications	L	T	P	Credits	Total marks
		2	0	2		
Pre requisite: NIL			Co Requisite: NIL			
Course Objectives • To explore the fundamental concepts of Artificial Intelligence (AI) • To assess the applicability, strengths, and weaknesses of the basic knowledge representation • To impart machine learning techniques • To understand various CNNs • To develop the solutions for real world problems using AI						
UNIT	CONTENTS					HOURS
I	OVERVIEW OF AI Evolution of AI, Applications of AI, Classification of AI systems, Knowledge Inferring systems and Planning, Uncertainty and towards Learning Systems, Problem solving by Search, Problem space, State space, Blind Search, Types, Performance measurement.					9
II	KNOWLEDGE REPRESENTATION First Order Predicate Logic, Prolog Programming, Unification, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information.					9
III	FOUNDATIONS FOR MACHINE LEARNING ML Techniques overview, Dimensionality Reduction, Clustering, Regression, Classification – Naïve Bayes; K-nearest Neighbours; SVM; Decision Trees, Ensemble methods					9
IV	UNDERSTANDING DEEP LEARNING Perceptron, Activation Functions, Artificial Neural Networks, Training Neural Networks, Convolutional Neural Networks, Evolution of CNN Architectures: AlexNet, VGG, ResNets, DenseNets, Recurrent Neural Networks.					9
V	APPLICATIONS AI applications, Information Retrieval, Machine Translation, Classification, Object Detection, Artificial Intelligence Techniques for Cyber-Physical, Digital Twin Systems and Engineering Applications					9

Maximum Hours: 45

Course Outcomes

On completion of the course, the student will be able to

CO1- Evaluate Artificial Intelligence methods.

CO2- Demonstrate knowledge of reasoning and knowledge representation for solving real world problems

CO3-Analyze various machine learning techniques

CO4-Identify suitable deep learning techniques for real world problems



CO5-Implement image classification and object detection systems

CO6-Solve real world problems in cyber physical systems using AI

TEXT / REFERENCE BOOKS

1. Phil Kim. "MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress, 2017.
2. Jan Erik Solem, "Programming Computer Vision with Python", Creative Commons, 2012.
3. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach, Prentice Hall, 3rd Edition, 2015.
4. Alpaydin, E., "Introduction to Machine Learning", 2nd edition, MIT Press, 2010.
5. Nils J. Nilsson, "The Quest for Artificial Intelligence", Cambridge University Press, 2009.
6. M. Tim Jones, "Artificial Intelligence: A Systems Approach (Computer Science)", Jones and Bartlett Publishers, Inc.; 1st Edition, 2008.
7. William F. Clocksin and Christopher S. Mellish, "Programming in Prolog: Using the ISO Standard", 5th Edition, Springer, 2003.



SECA1406 (NEW)		INDUSTRY 5.0 FOR ELECTRONICS ENGINEERS			L	T	P	Credit s	Total marks
					2	0	0	2	100
Pre requisite: NIL					Co Requisite: NIL				
Course Objectives ● To acquaint with the digital transformation of Industry 5.0 ● To recognize the power of industry to achieve societal goals beyond jobs and growth ● To understand the design of personalized electronics products ● To focus on methods of interaction between humans and machines ● To develop the concept of electronics manufacturing beyond automation and optimization									
UNIT	CONTENTS								HOURS
1	INDUSTRY 4.0 Introduction to Industry 4.0, Industry 4.0: The Fourth Industrial Revolution, History of Industry 4.0, Industry 4.0 by definition, Component of Industry 4.0, The opportunities in Industry 4.0, Industrial Internet, Smart Factory, Smart Buildings, Smart Manufacturing, Smart Farming.								9
2	INDUSTRY 5.0 Evolution from Industry 1.0 to 5.0, Introduction to Industry 5.0, Globalization and Emerging Issues, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Healthcare and Human computer interactions, Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Big Data and Advanced Analysis.								9
3	DIGITAL TRANSFORMATION TO SOCIETY 5.0 Digital Transformation, Introduction to Digital Transformation, Digital business transformation, Causes of disruption and transformation, Digital transformation myths and realities, Digital transformation across various industries, Retail industry, Urban Development, e-Governance and the public sector, Insurance industry, Healthcare, Food, Manufacturing, Disaster Control, Elements of Society 5.0, Data Driven to Society, Humanity Vs Society 5.0.								9
4	SMART WORLD Introduction: Sensing & actuation, Communication, Electronics in Smart city, 5G Technology, Communication protocols, Integration of Sensors in Robots and Artificial Intelligence, Human-Machine Interaction, Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management., Intellectual Property Rights- Case Studies - Milk Processing and Packaging Industries.								9



5	CYBER SECURITY IN INDUSTRY 5.0 Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Intellectual Property Rights (IPR) : Case Studies- Augmented Reality Virtual Reality	9
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Maximum Hours: 4

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify the digital transformation power of Industry 5.0 to achieve societal goals beyond jobs and growth

CO2 – Analyze enhanced new production models in electronics

CO3 – Implement various electronics manufacturing technologies beyond automation and optimization

CO4 – Design suitable sensors for smart world real time applications

CO5 – Evaluate the performance of various cyber physical systems

CO6 – Create personalized electronics products combining the various industry 5.0 Applications with deep knowledge on Intellectual Property Rights

TEXT / REFERENCE BOOKS

1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
Availability: https://www.amazon.in/Introduction-IoT-Sudip-Misra/dp/1108959741/ref=sr_1_1?dchild=1&keywords=sudip+misra&qid=1627359928&sr=8-1.
2. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
Availability: https://www.amazon.in/dp/1032146753/ref=sr_1_3?dchild=1&keywords=sudip+misra&qid=1627359971&sr=8-3
3. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
4. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016.
5. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016.



SECA4003	AUTONOMOUS DRONE TECHNOLOGY	L	T	P	Credits	Total Marks
		3	1	0	3	100

COURSE OBJECTIVES

- To introduce anatomy of Drones and their types.
- To Familiarize the Student's with aerodynamics of drones.
- To Understand the configuration of flight controllers and other systems in drones
- To understand the fundamentals of autonomous navigation
- To learn the applications of computer vision and AI in autonomous drones.

UNIT I ANATOMY OF DRONE

9 Hrs

Drones-Definition and Classifications--Anatomy of Drone - Mechanical Structures, Flight Controller, Sensors and Actuators, Electronic Speed Controller, Brushless Motors-Communication Systems-Batteries and Power supply unit

UNIT II AERODYNAMICS AND STABILITY

9 Hrs

Forces of flight, Principal axes and rotation of aerial systems - Longitudinal axis, Lateral (transverse) axis and Perpendicular axis, Equilibrium, Stability - Stable system, Unstable system and Neutrally stable system, Control — Roll, Pitch, Yaw and Throttle.

UNIT III DESIGN OF GROUND CONTROLLED DRONES

9 Hrs

Standards and Legal Restrictions for Drones - Frame type selection - Configuring Drones Compass calibration, Access calibration, Radio calibration, Flight mode calibration and Failsafe calibration – Case study- Drones for Aerial photography, Mapping and Surveying.

UNIT IV AUTONOMOUS NAVIGATION AND POSITIONING

9 Hrs

GPS/GNSS receivers, Inertial Navigation Systems (INS), LiDAR scanners, Ultrasonic sensors and visual camera - Simultaneous Location and Mapping-(SLAM)- Mission Planner.

UNIT V COMPUTER VISION AND AI FOR AUTONOMOUS DRONES

9 Hrs

Computer Vision and Multi-View Stereo Vision – 3D Vision System Development - – Case study - object detection, classification, Image Annotation, Data Annotation and airborne tracking using OpenCV and Pytorch

Max. 45 hrs



COURSE OUTCOMES:

On completion of the course, student will be able to

CO1– Apply the mathematical/engineering concepts in building drones

C02 –Analyze the mathematical relation between force, equilibrium, stability and the movement of drones

C03 – Select appropriate sensors and actuators for specific application requirements.

CO4 – Develop navigational systems for autonomous drones.

C05 – Appraise the performance of computer vision in drones

C06 – Design an autonomous drone for mission control application.

TEXT / REFERENCE BOOKS

1. Syed Omar Faruk Towaha, "Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266" Packt Publishing, 2018
2. Aaron Asadi, "Drones The Complete Manual. The essential handbook for drone enthusiasts", Imagine Publishing Limited, 2016
3. Neeraj Kumar Singh, Porselvan Muthukrishnan, Satyanarayana Sanpini, "Industrial System Engineering for Drones: A Guide with Best Practices for Designing", Apress, 2019
4. V Kishore Ayyadevara, Yeshwanth Reddy, "Modern Computer Vision with PyTorch", Packt, 2020.
5. K R Krishna, "Agricultural Drones: A Peaceful Pursuit", Apple Academic Press; CRC Press, 2018





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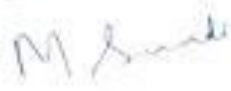
Minutes of Board of Studies Meeting held on 26th Nov 2022

(Time: 10.30 a.m. to 12 noon)

- Dr.N.M.Nandhitha, Prof. & Dean School of Electrical and Electronics started the meeting by welcoming both the external and the internal members to the Board of Studies meeting (26.11.2022, 10.00 a.m. to 12.00 noon)
- Dr.T.Ravi, Head, Dept. of Electronics and Communication Engineering informed the board that core competencies are identified from the feedback obtained from the students, faculty, Alumni and employers.
- The agenda of the meetings is to introduce Problem Based Learning Approach courses to the final year students. Dr.T.Ravi put forth the subjects such as 6G Wireless Technology, Medical Instrumentation and Imaging techniques and Cryptography in cybersecurity.
- Dr.K.Srilatha presented the syllabus for the course '6G Wireless Technology'. Dr.M.D.Selvaraj Associate Professor, IIITDM accepted new syllabus and suggested topics such as Extremely Large Aperture Massive MIMO and IoT, V2X Communication.
- Dr.S.Emelda Roslin presented the syllabus for Medical Instrumentation and Imaging techniques. Dr.N.Sivakumaran Prof., NIT Tiruchy suggested to include 3D/4D Sonography systems in the syllabus.
- Dr..A. Aranganathan discusses the course titled "Cryptography in cyber security" to the board members. Dr.Krishnamoorthy explained the need for inclusion of key management and distribution topic in cyber security. Dr.N.Sivakumar went through the syllabus and suggested the following topics include traditional problems associated with Cyber Crime, Introduction to Incident Response, Digital Forensics Phishing in the syllabus.
- Dr.M.Sugudev presented the syllabus for Anti Drone Systems. The members appreciated the introduction of the current technology course. Dr.M.D.Selvaraj suggested to include Drone Dome - Sky Drone – Drone Gun – ADRIAN – Laser Directed Energy Weapon (DEW) topics as case study.
- Having discussed the new course and the existing courses. Dr.T.Ravi presented the new syllabus introduced for PG 'Strategies in Industry 5.0' is also briefed by HOD. Dr.M.D.Selvaraj accepted the syllabus for all the courses.

The following internal members were present in the meeting.

Internal Members

1. Dr.N.M.Nandhitha 
2. Dr.T.Ravi 
3. Dr.M.Sumathy 
4. Dr.S.Lakshmi 
5. V.Vijaya Baskar 
6. Dr.P.Chitra 
7. Dr.P.Kavipriya 
8. Dr.S.Barani 
9. Dr.S.Poorna Pushpa Kala 
10. Dr.E.Annadevi 

External Members

Dr.N.Sivakumaran
Professor, Dept. of I & C
NIT, Trichy

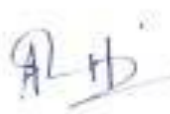


Dr.M.D.Selvaraj
Associate Professor
IIITDM, kancheepuram.

Mr.J.Visweswaran,
Academic Technical Consultant,
NI, Bangalore



Dr. Senthil Arunachalam ,
Director Automotive,
Jasmin Infotech Pvt. Ltd,
Chennai-119.





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**School of Electrical & Electronics
Department of Electronics & Communication Engineering
1.2.1 New Courses Introduced in 2022- 2023
CONTENTS**

SL.NO	COURSE CODE	COURSE NAME	FOCUSSED TOWARDS
1	SECA3034	6G Wireless Technology	Skill Development
2	SECA3036	Medical Instrumentation and Imaging techniques	Employability/ Entrepreneurship
3	SECA3035	Cryptography in cybersecurity	Skill Development
4	SECA3037	Anti Drone Systems	Employability/ Entrepreneurship
5	SECA5209	Strategies in Industry 5.0	Employability/ Skill Development

SECA3034	6G WIRELESS TECHNOLOGY	L	T	P	Credit s	Total marks
		2	0	2	3	100
Prerequisite: Wireless Communication		CoRequisite: NIL				
Course Objectives ● Learning the Basics of 5G and Beyond Wireless communication ● Providing a basic understanding of the channel methods and enablers of 5G and beyond communication systems. ● Study of 5G wireless channel models. ● Learning 5G techniques like massive MIMO, mmWave. ● Study of 6G Key Enablers..						
UNIT	CONTENTS					HOURS
I	INTRODUCTION AND FUNDAMENTALS OF WIRELESS COMMUNICATIONS Evolution of cellular systems requirements, goals, and vision of the next generation wireless communication systems fading, digital modulations.					9
II	5G CHANNEL METHODS OFDM and OFDMA, MIMO OFDM, Generalized Frequency Division Multiplexing (GFDM), Non-Orthogonal Multiple Access (NOMA), Universal Filtered OFDM.					9
III	mmWAVE mmWave Communications, Device-to-Device (D2D) Communication, 5G for Massive Machine Type Communication and Massive IoT, V2X Communication, Full Duplex and Green Communication, Massive MIMO and Beam forming techniques.					9
IV	6G KEY ENABLERS Wireless energy harvesting, machine learning, visible light communication, Intelligent reflecting surface (IRS), Extremely Large Aperture Massive MIMO.					9
V	WIRELESS ENERGY HARVESTING Energy-rate, trade-off, Simultaneous wireless information and power transfer (SWIPT), time-switching, power splitting Wireless powered communication networks.					9

Maximum Hours: 45

Course Outcomes

On completion of the course, the student will be able to

- CO1- Distinguish and understand the major cellular communication standards (1G/2G/3G/4G/5G/6G systems) and Wireless communications networks.
- CO2-Understand the various 5G techniques
- CO3- Understand the use of mm waves for the design of communication systems.
- CO4- Characterize and analyze various 6G Key Enablers.
- CO5-Implement the Machine Learning algorithms in 5G Wireless Communications
- CO6-Design Wireless powered Communication Network.

TEXT/REFERENCEBOOKS

1. T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock, *Millimeter Wave Wireless Communication*, Pearson Education , 2015.
2. M. Manish, G. Devendra, P. Pattanayak, and N. Ha, *5G and Beyond Wireless Systems PHY Layer Perspective*, Springer Series in Wireless Technology
3. M. Vaezi, Z. Ding, and H. V. Poor, *Multiple Access techniques for 5G Wireless Networks and Beyond*, Springer Nature , Switzerland, 2019.
4. R. Heath and A. Lozano, *Foundations of MIMO Communication*, Cambridge University Press , 2018.
5. Goldsmith Andrea, *Wireless Communications*, Cambridge University Press, First Edition ,2005
6. L.Hanzo,M.Munster, B.J.Choi and T.Keller, *OFDM and MC-CDMA for Broadband Multi-user Communications, WLANs and Broadcasting*, John Wiley & Sons,2003.

SECA3036	MEDICAL INSTRUMENTATION AND IMAGING TECHNIQUES	L	T	P	Credits	Total marks
		2	0	2	3	100
Pre requisite: Electronics Circuits		Co Requisite: NIL				
Course Objectives ● To explore the characteristics of biomedical signals and systems. ● To analyze the various electronics circuits used for medical signals conditioning ● To study and understand various assistive devices and monitors used in medical instrumentation ● To analysis the operation of various imaging equipments ● To implement various imaging techniques for real time medical applications						
UNIT	CONTENTS					HOURS
I	BIOPOTENTIAL MEASUREMENTS Sources of biomedical signals, Basic medical instrumentation system, Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, Standard lead system, Principles of vector cardiography. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG- unipolar and bipolar mode. Recording of ERG and EOG.					9
II	SIGNAL CONDITIONING CIRCUITS 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.					9
III	ASSISTIVE DEVICES AND MONITORS Cardiac Pacemakers, Heart lung machine- Oxygenators - Pumps, Monitoring Process. Hemodialyzer- Principle of Haemodialysis, Membranes, Dialysate, Different types of hemodialyzer's, Wearable Artificial Kidney, Defibrillators, Implantable defibrillators, Functional electrical stimulator (FES)					9
IV	IMAGING EQUIPMENTS X-Ray machine, CT - Scanning system, processing unit, viewing part & storage unit. MRI - The magnet, RF transmitter system, Gradient system, imager system, Advantages. Ultrasonic imaging systems - A Scan, B Scan, TM Mode Scan, Echocardiography.					9
V	RECENT ADVANCES IN IMAGING TECHNIQUES Biomedical Applications Thermographic Equipment, Mobile units of Computer Radiography & Digital Radiography system, 3D/4D Sonography systems, Mammography, Angiography, Endoscopy, Capsule Endoscopy, Laparoscopy. Foetal Monitoring System.					9

Maximum Hours: 45

Course Outcomes

On completion of the course, the student will be able to

CO1- Apply Suitable biomedical signals for medical instruments

CO2-Analyze suitable signal conditioning circuits for the medical instruments

CO3-Analyze Various assistive devices and monitors used for medical instrumentation

CO4-Identify the techniques used in various imaging systems

CO5-Implement various imaging techniques for real time medical applications on real time imaging system

CO6-Design an instrument for real time medical application

TEXT / REFERENCE BOOKS

1. Rafael C. Gonzalez, Richard E. Woods," Digital Image Processing", Pearson , Second Edition, 2004
2. John G. Webster, Medical Instrumentation Application and Design, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 2004.
4. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003.
5. Khandpur R.S, Handbook of Biomedical Instrumentation, 3rd edition, Tata McGrawHill New Delhi, 2014
6. Step by Step CT; Step by Step MRI and MRI made Easy for beginners – Govind B. Chavhan – Jaypee brothers and Medical Publishers (p) Ltd, New Delhi CT & MRI protocol – Satish K. Bhargava, CBS publishers.
7. R. Ananda Natarajan, Biomedical Instrumentation and Measurements, 2nd Edition, PHI, 2016.

SECA3035	CRYPTOGRAPHY AND CYBER SECURITY	L	T	P	Credits	Total marks
		3	0	0	3	100
Pre Requisite: NIL		Co Requisite:NIL				
Course Objectives ● To analyze basics of Cryptography. ● To apply the concepts of public key cryptography ● To implement the methods for authentication, access control, intrusion detection and prevention. ● To introduce the basic concepts of cyber crime and security ● To acquire knowledge on cyber threats and attacks						
UNIT	CONTENTS					HOURS
I	INTRODUCTION AND MATHEMATICAL FOUNDATIONS Services, Mechanisms and attacks-the OSI security architecture-network Security model-Classical encryption techniques. Finite fields and Number theory: - Introduction to group,ring and field - Prime numbers – Modular arithmetic - The Chinese Remainder Theorem – Discrete Logarithms.					9
II	SYMMETRIC KEY CIPHERS AND ASYMMETRIC KEY CIPHERS Symmetric key ciphers: Block Cipher principles, DES, AES, Block cipher operation, Stream ciphers, RC4. Asymmetric key ciphers: Principles of public key cryptosystems, RSA algorithm, ElGamal Cryptography, Diffie-Hellman Key Exchange, Knapsack Algorithm.					9
III	HASH FUNCTIONS, KEY MANAGEMENT AND DISTRIBUTION Cryptographic Hash Functions: Message Authentication, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures. Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509, Public – Key Infrastructure					9
IV	INTRODUCTION TO CYBER SECURITY AND CYBER CRIME Introduction to Cyber Security – Goals – Need for Security – Security Approaches– Principles of Security – Balancing Security & Access – Software Development Life Cycle – Security Systems Development Life Cycle – Security Professionals and the organization. Introduction to Cyber Crime and Security: Cyber Crimes, types of Cyber Crime, Cyber Space and criminal behavior, traditional problems associated with Cyber Crime, Introduction to Incident Response, Digital Forensics – Phishing.					9

V	CYBER SECURITY-THREATS AND ATTACKS Threats: Intellectual Property – Types of Cyber Attacks – Deviations in QoS – Espionage – Forces of Nature – Human Error – Information Extortion – Missing, inadequate or incomplete organization policy – Missing, inadequate or incomplete controls – sabotage – Theft – Hardware Failures –Software Failures Attacks: Malicious Code – Hoaxes – Back Doors – Password Crack – Brute Force – Spoofing – Man-in-the-Middle – Spam –Email Bombing – Sniffers – Social Engineering – Pharming – Timing Attack.	9
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Maximum Hours:45

Course Outcomes

On completion of the course, the student will be able to

- CO1: Understand the various Cryptographic Technique.
- CO2: Apply the various Symmetric and Asymmetric key Ciphers
- CO3: Implement Hashing and Digital Signature techniques
- CO4: Analyze the basic concepts of cyber security and cyber crime
- CO5: Scrutinize the various cyber threats and attacks
- CO6: Explore the significant aspects of cyber security

TEXT/REFERENCE BOOKS

1. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security", CENGAGE Learning, 4th Edition.
2. William Stallings, "Cryptography and Network Security-Principles and Practice", Pearson Education, 7th Edition.
3. Atul Kahate, "Cryptography and Network Security", McGraw Hill, 4th Edition.
4. Neal Koblitz "A course in Number Theory and Cryptography" Springer-Verlag 1994
5. Alfred J Menzies, Paul C Van Oorshot and Scott A. Vanstone "Handbook of Applied Cryptography", CBC Press, 1996
6. Matthew P. Barrett, Cybersecurity, Critical Infrastructure. "Framework for Improving Critical Infrastructure Cybersecurity." Framework 1 (2014): 11

SECA3037	ANTI DRONE SYSTEMS	L	T	P	Credits	Total marks
		2	0	2	3	100
Pre requisite: NIL		Co Requisite: NIL				
Course Objectives						
- To introduce anatomy of Drones and their types. - To familiarize the Student's with communication standards for Drones. - To understand the fundamentals of drone detection and tracking. - To familiarize the student with various drone interdiction techniques. - To study different anti drone systems deployed in various countries						
UNIT	CONTENTS					HOURS
I	ANATOMY OF DRONE Drones - Definition and Classifications - Anatomy of Drone - Mechanical Structures, Flight Controller, Sensors and Actuators, Electronic Speed Controller, Brushless Motors- Mechanical Design - Batteries and Power supply unit.					9
II	DRONE COMMUNICATION SYSTEMS Radio Frequency Regulation - Communication Protocols – Blockchain for Drone Communication - RF Transceiver architectures.					9
III	DRONE DECTION AND TRACKING Detection Techniques – Radars, Radio Frequency Scanning, Electro-Optical (EO) sensors for Visual Signature Identification, Infrared sensors based Heat Signature Detection, Acoustic signature detection -Threat Identification.					9
IV	DRONE INTERDICTION RF Jamming, Spoofing, Lazer Dazziling, Nets, High power microwave beams, Collision drones - System Architecture for coordinated Drone Interdiction.					9
V	UNIT V CASE STUDY Drone Dome - Sky Drone – Drone Gun – ADRIAN – Laser Directed Energy Weapon (DEW) .					9

Maximum Hours: 45

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1 — Apply the engineering concepts in building drones.

CO2 — Analyze the communication protocols used in drones.

CO3 — Apply appropriate technique to detect drones.

CO4 — Apply appropriate technique to interdict unanimous drones.

CO5 — Appraise the performance of different drone detection systems.

TEXT / REFERENCE BOOKS

- [1] Aaron Asadi, "Drones The Complete Manual. The essential handbook for drone enthusiasts", Imagine Publishing Limited, 2016.
- [2] Neeraj Kumar Singh, Porselvan Muthukrishnan, Satyanarayana Sanpini, "Industrial System Engineering for Drones: A Guide with Best Practices for Designing", Apress, 2019.
- [3] Garik Markarian, Andrew Staniforth, "Counter measures for Aerial Drones, Artech House, 2020.
- [4] Arthur Holland Michel, "Counter-drone Systems", Center for the Study of the Drone at Bard College, 2018.

SECA5209		STRATEGIES IN INDUSTRY 5.0			L	T	P	Credit s	Total marks
		2	0	0	2		100		
Pre requisite: INDUSTRY 4.0					Co Requisite: NIL				
Course Objectives ➤ To acquaint with the digital transformation of Industry 5.0 ➤ To recognize the power of industry to achieve societal goals beyond jobs and growth ➤ To understand the design of personalized electronics products ➤ To focus on methods of interaction between humans and machines in virtual reality ➤ To develop the concept of augmented reality in electronics manufacturing beyond automation and optimization									
UNIT	CONTENTS								HOURS
1	INDUSTRY 5.0 Evolution from Industry 1.0 to 5.0, Introduction to Industry 5.0, Globalization and Emerging Issues, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Healthcare and Human computer interactions, Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Big Data and Advanced Analysis.								9
2	DIGITAL TRANSFORMATION TO INDUSTRY 5.0 Digital Transformation, Introduction to Digital Transformation, Digital business transformation, Causes of disruption and transformation, Digital transformation myths and realities, Digital transformation across various industries, Retail industry, Urban Development, e-Governance and the public sector, Insurance industry, Healthcare, Food, Manufacturing, Disaster Control, Elements of Society 5.0, Data Driven to Society, Humanity Vs Society 5.0.								9
3	SMART WORLD Introduction: Sensing & actuation, Communication, Electronics in Smart city, 5G Technology, Communication protocols, Integration of Sensors in Robots and Artificial Intelligence, Human-Machine Interaction, Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management., Intellectual Property Rights- Case Studies - Milk Processing and Packaging Industries.								9
4	CYBER SECURITY IN INDUSTRY 5.0 Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Intellectual Property Rights (IPR).								9
5	AR/VR IN INDUSTRY 5.0 Unity, Basics of Unity, Understanding different panels in Unity, Moving, rotating & scaling Gameobjects in Unity, Game Panel in Unity, Physics in Unity, Increasing the light intensity, Adding colors to Gameobject, Adding textures to Gameobject, Parent and child Gameobjects in Unity. Case Studies- Development of AR/VR Models in Unity.								9

Maximum Hours: 45

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 – Identify the digital transformation power of Industry 5.0 to achieve societal goals beyond jobs and growth
- CO2 – Analyze enhanced new production models in electronics
- CO3 – Implement various electronics manufacturing technologies of augmented reality beyond automation and optimization
- CO4 – Design suitable sensors for smart world real time applications with virtual reality experience
- CO5 – Evaluate the performance of various cyber physical systems
- CO6 – Create personalized electronics products combining the various industry 5.0 Applications with deep knowledge on Intellectual Property Rights

TEXT / REFERENCE BOOKS

1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
Availability:https://www.amazon.in/Introduction-IoT-Sudip-Misra/dp/1108959741/ref=sr_1_1?dchild=1&keywords=sudip+misra&qid=1627359928&sr=8-1.
2. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
Availability:https://www.amazon.in/dp/1032146753/ref=sr_1_3?dchild=1&keywords=sudip+misra&qid=1627359971&sr=8-3
3. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
4. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016..
5. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
6. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
7. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016