Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

Syllabus for
Final Year B. Tech.
Electronics & Telecommunication
(Pattern 2020)

Department of
Electronics & Telecommunication
Engineering

VISION:

Empowering students to be resourceful Electronics and Communication engineers with holistic development

MISSION:

- To provide conducive environment of academic and research with multidisciplinary approach through experiential learning
- To ensure strong industry collaboration in creating innovation culture through sustainable technologies
- Prepare engineering professionals with highest ethical values and a sense of responsible citizenship

Program Educational Objectives (PEO):

1. Graduates of the program will become competent electronic engineers suitable for industry.
2. Graduates of the program will apply the mathematical and analytical abilities gained through core courses of Electronics and Communication engineering.
3. Graduates of the program will apply problem solving skills to develop hardware and/or software.
4. Graduates of the program will become responsible citizen.

Program Outcomes (PO):

A graduate of the program will have

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding ofthe engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO):

Graduates will be able to

1. Apply and demonstrate the usage of hardware and software platforms for variety of applications.

2. Apply different mathematical and statistical methods for analysis and design of signal processing and communication systems.

Graduate attributes:

1. Engineering knowledge
2. Problem Analysis
3. Design/Development of Solutions
4. Investigations of Complex Problems
5. Modern Tool Usage
6. The Engineer and Society
7. Environment and sustainability
8. Ethics
9. Individual and Teamwork
10. Communication
11. Project management and Finance
12. Life –long Learning

Final Year B. Tech. Electronics & Telecommunication Engineering (Pattern 2020)
Module I (AY 2023-24)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	OR		
ETUA40201	Deep Learning and Edge AI	TH	2	-	-	20	20	20	40	-	100	2
ETUA40202	Professional Elective III	TH	2	-	-	20	20	20	40	-	100	2
IOEUA40203	Open Elective II	TH	2	-	-	20	20	20	40	-	100	2
IOEUA40204	Open Elective III	TH	2	-	-	20	20	20	40	-	100	2
ETUA40205	Research Methodology and IPR	CE	2	-	-		-	50	-	-	50	2
ETUA40206	Major Project	CE-PR/OR	-	-	20	100	-	-	-	50	150	10
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		10	-	20	180	80	130	160	50	600	20

L: 1Hr. = 1 Credit, P: 2 Hrs. = 1 Credit, T: 1 hr. = 1 Credit, Audit Course: No Credits

List of Mandatory Courses [FYBT: Induction training, SYBT: Environmental Sciences, TYBT: Essence of Indian Traditional Knowledge, and Final Year B.Tech.: Indian Constitution].

Open Elective -II	Open Elective -III
IOEUA40203A: Introduction to Industry 4.0 and Industrial IOT	IOEUA40204A: Social Media Analytics
IOEUA40203B: Software Testing and Quality Assurance	IOEUA40204B: Organizational Behavior
IOEUA40203C : Data Centric AI	IOEUA40204C : Data Ethics
IOEUA40203D : Computer Vision	IOEUA40204D : Business Intelligence
IOEUA40203E : Project Management: Planning, Execution, Evaluation and Control	IOEUA40204E : Business Analytics
IOEUA40203F : Solar and Wind Energy	IOEUA40204F : Project management and Economics

Professional Elective -III
ETUA40202A: Analog IC Design
ETUA40202B: Smart Antennas
ETUA40202C : Power Electronics for Electric Vehicle
ETUA40202D : Image and Video Processing

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Final Year B. Tech. Electronics & Telecommunication Engineering (Pattern 2020)
Module II (AY 2023-24)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
ETUA40207	Semester Internship (Research / Industry)	CE-PR/OR	-	-	20	100	-	-	-	50	150	10
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		-	-	20	100	-	-	-	50	150	10

Final Year B. Tech. Electronics & Telecommunication Engineering (Pattern 2020)
Module III (AY 2023-24)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	TW PR/ OR		
ETUA42201	Professional Elective IV	TH	3	-	2	20	20	20	40	25	125	4
IOEUA42202	Open Elective IV	TH	3	-	-	20	20	20	40	25	125	3
IOEUA42203	Open Elective V	TH	3	-	-	20	20	20	40	25	125	3
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
			9	-	2	60	60	60	120	75	375	10

Professional Elective IV
High Performance Computing

Open Elective IV
Supply Chain Management

Open Elective V
Natural language Processing

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Final Year B. Tech. Electronics & Telecommunication Engineering (Pattern 2020)
Module IV (AY 2023-24)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
ETUA40207	Semester Internship (Research / Industry)	CE-PR/OR	-	-	20	100	-	-	-	50	150	10
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		-	-	20	100	-	-	-	50	150	10

NOTE:
Students who will register for Module-I in Semester VII have to register either of Module-III or Module-IV in Semester VIII.
Students who will register for Module-II in Semester VII have to register for Module-V in Semester VIII.

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Final Year B. Tech. Electronics & Telecommunication Engineering (Pattern 2020)
Module V (AY 2023-24)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	OR		
ETUA40201	Deep Learning and Edge AI	TH	2	-	-	20	20	20	40	-	100	2
ETUA40202	Professional Elective III	TH	2	-	-	20	20	20	40	-	100	2
IOEUA40203	Open Elective II	TH	2	-	-	20	20	20	40	-	100	2
IOEUA40204	Open Elective III	TH	2	-	-	20	20	20	40	-	100	2
ETUA40205	Research Methodology and IPR	CE	2	-	-		-	50	-	-	50	2
ETUA40206	Major Project	CE-PR/OR			20	100				50	150	10
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		10	-	20	180	80	130	160	50	600	20

L: 1Hr. = 1 Credit, P: 2 Hrs. = 1 Credit, T: 1 hr. = 1 Credit, Audit Course: No Credits

List of Mandatory Courses [FYBT: Induction training, SYBT: Environmental Sciences, TYBT: Essence of Indian Traditional Knowledge, and Final Year B.Tech.: Indian Constitution].

Open Elective -II	**Open Elective -III**
IOEUA40203A: Introduction to Industry 4.0 and Industrial IOT	IOEUA40204A: Social Media Analytics
IOEUA40203B: Software Testing and Quality Assurance	IOEUA40204B: Organizational Behavior
IOEUA40203C : Data Centric AI	IOEUA40204C : Data Ethics
IOEUA40203D : Computer Vision	IOEUA40204D : Business Intelligence
IOEUA40203E : Project Management: Planning, Execution, Evaluation and Control	IOEUA40204E : Business Analytics
IOEUA40203F : Solar and Wind Energy	IOEUA40204F : Project management and Economics

Professional Elective -III
ETUA40202A: Analog IC Design
ETUA40202B: Smart Antennas
ETUA40202C : Power Electronics for Electric Vehicle
ETUA40202D : Image and Video Processing

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Module – I & V

ETUA40201: Deep Learning and Edge AI

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): - Practical (P): -	20	20	20	40	-	-	100

Prerequisite: Readers/students are expected to know the following concepts:
Machine Learning ,Statistics and Probability , Embedded Systems

Course Outcomes: At the end of this course, students will be able to

1. Develop the Convolutional neural networks and YOLO based object and face recognition applications.
2. Design and Evaluate Recurrent Neural Networks ,Long Short Term Memory and apply them in Natural Language Processing.
3. Analyze and compare different types of Autoencoders and apply them in dimensionality reduction.
4. Design and evaluate the Generalized Adversarial Networks.
5. Demonstrate the reinforcement learning and apply its principles in robotic systems.
6. Develop image classification system using tensorflow lite and mobile /raspberry Pi.

Unit- I : CNN and its applications

Study of pre trained networks like VGG, Googlenet, ResNet, Visualization of VGG, Object classification using CNN, Object localization, Sliding window approach, Intersection of Unions, Regional CNN, concept Anchor boxes, YOLO algorithm and its variants, non -maxima suppression, Applications in Face recognition and Image segmentation.

Unit- II : Recurrent Neural Networks

RNN: - One hot word representation, word embedding, word to Vec, Sequence modelling, RNN,Bidirectional RNN, Vanishing Gradient Problem, LSTM and applications in natural language processing, Time series forecasting with RNNs/LSTM's. ,Gated Recurrent Units . Attention mechanism, Vision Transformers, Applications of Vision transformers in image classification.

Unit –III : Autoencoders and Variational autoencoders

Principle of Autoencoders, Auto encoder Vs PCA, Training Autoencoders , Sparse Autoencoder, Denoising Autoencoder, Contractive Autoencoder ,Case studies using denoising CNN. Principles of VAEs, Variational inference, Conditional Auto and Variational autoencoders. Applications of VAE's.

Unit IV: Generative Adversarial Networks

Generative and discriminative models, Principles of GANs, Architecture structure basics, Deep Convolution Generative Adversarial Network (DCGAN),Conditional GAN (CGAN), Image translation using cycle GAN's. Case studies using GAN's such as Image de-raining/ Super resolution etc.

Unit V: Reinforcement learning

Principles of reinforcement learning (RL),The Q value,Q-Learning example, Nondeterministic environment ,Temporal-difference learning ,Deep Q-Network (DQN),Double Q-Learning (DDQN), Policy learning, Applications of RL in robotics.

Unit VI : Edge AI devices and solutions

Introduction to edge computing and devices used for Edge Machine learning, advantages and disadvantages, Technologies involved in Edge development , Overview of supported Hardware like NVIDIA Jetson Nano, Coral and raspberry Pi, Model design with compression tools. Use of tensorflow for deployment over edge.

Text Books :

1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville, "*Deep learning*", MIT press, 2016.
2. Atienza, Rowel. *Advanced Deep Learning with Keras: Apply deep learning techniques, autoencoders, GANs, variational autoencoders, deep reinforcement learning, policy gradients, and more*. Packt Publishing Ltd, 2018.
3. Michelucci, Umberto. *Advanced applied deep learning: convolutional neural networks and object detection*. Apress, 2019.
4. www.tensorflow.org

Reference Books:

1. Christopher Bishop, "*Pattern Recognition and Machine Learning*", Springer, 2007.
2. Josh Kalin ," *Generative Adversarial Networks Cookbook* " Packt Publishing Birmingham,2018
3. Zhou, Xichuan, Haijun Liu, Cong Shi, and Ji Liu. *Deep Learning on Edge Computing Devices: Design Challenges of Algorithm and Architecture*. Elsevier, 2022.

List of Experiments:

All programs are expected to be written in Python using tensorflow ,keras and other relevant libraries.

1) Programming for Visualization of CNN's.

2) Develop a program using tensorflow and keras libraries to implement CNN based architecture which will detect the objects in the test images and provide its class and bounding box location as an output.

3) Implementation of RNN for text Classification.

4) Develop and test Autoencoder for MNIST data.

5) Implement and test Variational Autoencoder /Convolutional VAE over MNIST dataset. Compare its performance over Autoencoder.

6) Develop the Generator and discriminator in Generative adversarial network and test over MNIST dataset.

7) Build and train RL model using keras functions and develop application based on it.

8) Deployment of CNN based image classification /Object detection / Pose estimation on iOS/ Raspberry

ETUA40202A: Professional Elective III: Analog IC Design

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): - Practical (P): -	20	20	20	40	-	-	100

Prerequisite: Students are expected to know the concepts studied in following courses:

1. Electronic Devices and Circuits
2. Engineering Circuit Analysis

Course Objectives:

- To get acquainted with MOS transistor models and CMOS fabrication process.
- To analyze and design single-stage and differential amplifiers.
- To realize and understand the need of current mirrors and biasing techniques for analog CMOS circuits.
- To analyze and design different types of operational amplifiers.
- To study different types of bandgap reference circuits.

Course Outcomes: At the end of this course, students will be able to

1. Construct low and high-frequency model of MOS transistors.
2. Analyze and design single-stage amplifiers.
3. Analyze and design differential amplifiers.
4. Understand current mirrors and biasing circuits and it's usage in designing amplifiers.
5. Analyze and design operational amplifiers for a given specifications.
6. Cognize different bandgap reference circuits and its applications.

Unit I: MOS Transistor Theory **(4 Hours)**

Introduction to MOSFET, MOS device capacitances, MOS small-signal low-frequency and high-frequency model, MOS SPICE models.

Unit II: Single-Stage Amplifiers **(4 Hours)**

Common-source stage with different type of loads, Source follower, Cascode and folded-cascode stage. Frequency response of CS amplifier.

Unit III: Differential Amplifiers **(4 Hours)**

Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads, and frequency response of differential pair with passive and active loads.

Unit IV : Current Mirrors and Biasing Techniques **(4 Hours)**

Basic and cascode current mirrors, Active current mirrors, Large-signal and small-signal analysis, Biasing techniques: CS biasing, Source follower biasing, and Differential pair biasing.

Unit V: Operational Amplifiers **(4 Hours)**

One-stage op amps, Telescopic and folded-cascode op amps, Two-stage op amps, Common-mode feedback, High slew rate op amps.

Unit VI: Bandgap References **(4 Hours)**

Supply independent biasing, Temperature-independent references, PTAT current generation, Constant-Gm biasing, Low-voltage bandgap references.

Text Book :

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits," 2nd Edition, Mc Graw Hill.

Reference Books :

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits," 5th Edition, Wiley.
2. Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design," 2nd Edition, Oxford University Press.

ETUA40202B: Professional Elective III: Smart Antennas

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): - Practical (P): -	20	20	20	40	-	-	100

Prerequisite: Readers/students are expected to know the following concepts:
1. Basics of Antennas

Course Objectives:
- To understand the fundamental concepts of antennas
- Analyze the performance of smart antennas
- Demonstrate the design and implementation of smart antennas
- To apply smart antennas in real-world scenarios
- Evaluate the limitations and future directions of smart antennas

Course Outcomes: At the end of this course, students will demonstrate the ability to
1. Design and optimize a smart antenna system using simulation tools such as CST and MATLAB
2. Analyze the performance of antenna systems under different scenarios
3. Apply antennas in real-world scenarios
4. Evaluate the benefits and limitations of smart antenna technology
5. Demonstrate an understanding of the fundamental concepts of smart antennas
6. Communicate effectively about antennas

Unit I : Fundamentals of Antenna Theory
- Antenna parameters (gain, directivity, polarization, etc.)
- Radiation pattern and antenna arrays
- Basics of antenna modeling and design
- Antenna performance and measurement
- Smart Antenna basics

Unit- II : Radiation from Wires and Loops
- Overview of wire antennas: Dipole antenna, monopole antenna
- Radiation patterns and characteristics
- Loop antennas: Circular loops, square loops
- Radiation mechanism and applications

Unit III: Aperture Antennas
- Introduction to aperture antennas: Horn antenna, slot antenna, reflector antenna
- Characteristics and applications, Radiation patterns and gain

Unit IV: Broadband Antennas
- Design considerations for broadband antennas
- Wideband dipole antennas, log-periodic antennas
- Broadband characteristics and applications

Unit V: Microstrip Antennas

- Introduction to microstrip antennas
- Design structure and fabrication process
- Advantages and limitations
- Applications in wireless communication systems

Unit VI: Smart Antenna Applications

- Beamforming techniques and antenna array pattern
- Adaptive beamforming and null steering
- Spatial processing techniques
- Smart antenna applications in wireless communication systems

Text Books :

1. Antenna Theory: Analysis and Design" by Constantine Balanis (Wiley)
2. "Smart Antennas with MATLAB" by Frank Gross (Wiley-IEEE Press)

Reference Books:

3. Introduction to Smart Antennas" by Constantine Balanis and Benjamin Bahr (Morgan & Claypool Publishers)
4. "Handbook of Smart Antennas for RFID Systems" by Nemai Chandra Karmakar and Yang Hao (CRC Press)
5. "Smart Antennas for Wireless Communications: IS-95 and Third Generation CDMA Applications" by Thomas W. Miller (Prentice Hall PTR)
6. "Adaptive Antennas and Phased Arrays for Radar and Communications" by Alan J. Fenn (Wiley-Interscience)

List of Experiments:

1. Design and analyze a wire antenna, such as a dipole or monopole antenna, using CST software.
2. Microstrip Antenna Design and Analysis using CST
3. Design and optimize a broadband antenna using CST software
4. Array Antenna Design and Beamforming using CST/MATLAB
5. Smart Antenna Design using CST/ MATLAB

ETUA40202C: Professional Elective III :Power Electronics for Electric Vehicles

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/**OR**	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): - Practical (P): -	20	20	20	40	-	-	100

Prerequisite: Readers/students are expected to know the following concepts:

2. Electrical machines – Motors
3. Power Electronics – Devices and Circuits
4. Vehicle Dynamics

Course Objectives:

- To introduce EV market, challenges, and opportunities in E-Mobility
- To make able to break EV into sub-system, resolve dependencies and calculate requirements.
- To explain the construction and working of various Electric drives
- To prepare students to able to design power sub-systems in EVs and to integrate it

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Analyse EVs based on power sources and calculate range of an EV
2. Understand the Vehicle Drivetrain and estimate power requirement / range calculation
3. Select Suitable Converter scheme for the target Electric Vehicles
4. Perform motor power and torque calculations to select a motor for EV
5. Appreciate the importance of battery/ FC technology in e-mobility domain.
6. Identify various communication protocols and technologies used in vehicle networks

Unit- I: Introduction to Electric Vehicles

Timeline of Development of EV technology, Overview and Types of EV, Functional Block Diagram of EV/ HEV, Types and Arrangements of EVs, EV and Automobile market overview. Carbon emission – reduction, Emerging trends – Hybridizations, Fuel cell Vehicles. E _Mobility as future.

Unit- II: EV Technology: Functional Electronics and Drivetrain

Different EV architectures, System and sub-systems, Modelling and design of EVs as a system, principles of controls engineering for EV, Propulsion unit and drivetrain requirements. Finalizing the vehicle specifications and simulate the energy consumption for electric vehicle, simulation using SCILAB.

Unit –III: Power Converters and Control Circuits

Power Converters – Controlled Rectifiers for Chargers, PWM Inverters, Four Quadrant Choppers, Sensing arrangements and Control of Converters / Inverters, Protection and Safety systems for Energy source, Power Converter and motors. Four quadrant operation - Regenerative braking.

Unit IV: Motors and Drives in EV: Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. Comparison of EV motors, Motor dynamics and control using PID controllers, BLDC and PMDC motor drives, Induction motors in EV – VVVF control

Unit V: Energy Storage Systems and Management: Energy requirement of EV, Storge Systems – Energy and Power Density, Battery – Li-Ion, Super capacitors, Fuel Cells and Hybridization of energy sources, Battery Management system, Charging Systems, Infrastructure and Protection, Battery recycling.

Unit VI: Communication and Security:

Communication protocols – I2C, CAN and MODBUS, Usage of GPS and vehicle tracking, Vehicular network, Internet inside vehicle, Security of EV – Possible attacks and cyber security of EV. Sensing and dashboarding of sub-system and vehicle parameters on dashboard and over network, remote diagnostic of vehicle faults.

Textbooks:

1. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz M. Ebrahimi , "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles",
2. Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India
3. Mehrdad Ehsani, Yimin Gao, Sebastian E.Gsay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell vehicles-Fundamentals - Theory and Design", CRC Press

Reference Books:

1. D. A. J. Rand, R. Woods, and R. M. Dell, "Batteries for Electric Vehicles," Society of Automotive Engineers," Warrendale PA, 2003.
2. EV201 course - https://www.pupilfirst.school/courses/643/curriculum
3. NPTEL Course on EV: https://nptel.ac.in/courses/108102121
4. Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning
5. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.

List of Experiments:

a. Using Hardware Resources (Any Four)
   1. To perform Speed Control of DC motor under different loading conditions.
   2. To evaluate performance of Charger for different batteries / Supercapacitors
   3. To perform speed – torque characteristics for BLDC motor drive.
   4. To demonstrate/ evaluate various protection circuits for Converters and Energy storages.
   5. To measure different parameters of battery using Battery Management System

b. Using Simulations (Any Four)
   1. Simulate different battery models using scilab and observe charge – discharge cycle.
   2. Simulate Chopper based DC drive using scilab
   3. Simulation of Four quadrant operation of three phase induction motor
   4. Simulate Battery Management System using Scilab
   5. Simulate I2C / CAN bus for BMS communication or fault detection

c. Mini-Project / Experiential Learning (Any One)
   1. Case Study: Design, selection, sizing and components of any developed charging station for EV
   2. Visit to EV manufacturing unit in Pune or EV sub-system manufacturing facilities like Batteries, Motors, Drives or Energy Systems.
   3. For a specific client requirement / case – Select EV after comparison on Performance and RoI parameters.

ETUA40202D: Professional Elective IV: Image and Video Processing

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	OR	TW	Total
Lecture (L): 2 hrs./week	20	20	20	40	-	--	100

Prerequisite: Readers/students are expected to know the following concepts:
Basic Programming skills, Signal Processing fundamentals, Basic linear algebra, Basic python

Course Objectives:

- To learn the fundamental concepts of image and video processing
- To design and implement algorithms for image enhancement, smoothing and sharpening of images
- To make the students understand the techniques used in image segmentation, morphological image processing and use them for feature extraction
- To understand and compare different techniques for image compression and image restoration
- To equip students to apply the image processing techniques in real life applications

Course Outcomes: At the end of this course, students will be able to

7. Understand the steps in digital image processing and perform basic operations on gray and color images
8. Apply spatial domain and frequency domain filters for image enhancement, smoothing and sharpening
9. Perform image segmentation and morphological image processing
10. Apply image processing techniques for extraction of features in the image
11. Compare different techniques for image compression and image restoration
12. Understand the steps in video processing and perform basic operations

Unit- I : Fundamentals of Image Processing

Introduction to Image Processing. Examples of Fields that use Image Processing, Fundamental Steps in Image Processing, Human visual system, Image acquisition, Sampling & quantization, representing digital images, Spatial & gray-level resolution, Image file formats, Basic relationships between pixels, Distance Measures, Statistical properties of images-histogram, mean, variance, MSE, PSNR.
Color Image fundamentals & color models – RGB, CMY,HSI ,YIQ.

Unit –II : Image Processing in spatial and frequency domain

Basic Mathematical Tools Used in Digital Image Processing, Elementwise versus Matrix Operations, Linear versus Nonlinear Operations, Arithmetic Operations, Intensity Transformations and Spatial Filtering: Basic Intensity Transformation, Histogram Processing, Fundamentals of Spatial Filtering: 2D convolution, smoothing and sharpening filters
Filtering in the Frequency Domain: 2D DFT, Smoothing and Sharpening in frequency domain.

Unit III : Image Segmentation and Morphological Image Processing

Image Segmentation: Point, Line, and Edge Detection-Gradient Operators, Advanced Techniques for Edge Detection -Marr-Hildreth Edge Detector, Canny Edge Detector, Edge linking- Hough Transform, Thresholding –Otsu's Method, Variable Thresholding Based on Moving Averages, Segmentation by Region Growing and by Region Splitting and Merging, Segmentation Using Clustering and Superpixels , Active Contours: Snakes and Level Sets, Segmentation Using Graph Cuts, Morphological Operations: Dilation, Erosion, Opening, Closing, Boarder extraction

Unit IV : Feature Extraction

Boundary Preprocessing, Boundary Feature Descriptors, Region Feature Descriptors, Principal Components as Feature Descriptors, Harris-Stephens Corner Detector, Scale-Invariant Feature Transform (SIFT) features, SURF features, Pattern Classification: Minimum-Distance Classifier, Deep Convolutional Neural Networks for feature extraction

Unit V : Image Compression and Image restoration

Types of redundancy, Bit-plane coding, lossless versus Lossy compression, Introduction to DCT, Wavelet transforms, Lossy compression – DCT based compression, Introduction to JPEG, Image Degradation/Restoration Process, Noise models and Restoration of images degraded due to noise, Inverse and Wiener Filtering

Unit VI : Fundamentals of video Processing

Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Motion Estimation; Video Filtering; Video Compression, Video coding standards MPEG, Concept of sparsity in image and video processing ,Case studies of Image and video processing

Text Books :

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Fourth Edition, - Pearson Education 4th Edition
2. Iain E. G. Richardson, ―H.264 and MPEG Video Compression: Video Coding for Next-generation Multimedia. Wiley

Reference Books :

1. Sonka ,et al. Image processing, analysis and machine vision
2. Alan C. Bovik, Handbook of Image and video processing, Academic press, 2010
3. AK. Jain, Fundamentals of digital image processing, Prentice Hall of India
4. M.A. Joshi et al, Image and Video Compression: Fundamentals, Techniques & Applications, CRC press

IOEUA40203D: Computer Vision (Open Elective –II)

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 Tutorial (T): - Practical (P): -	20	20	20	40	-	-	100

Prerequisite: Readers/students are expected to know the following concepts:
Machine Learning

Course Outcomes: At the end of this course, students will be able to

1. Apply concepts of geometric transformations in Image formation
2. Apply image transforms in gray and color image preprocessing.
3. Analyze the extracted features for computer vision model fitting.
4. Understand deep learning models for use in computer vision applications.
5. Estimate the depth of the objects in the environment.
6. Design the computer vision models for applications like object tracking , segmentation of medical images .

Unit- I : Introduction to Computer Vision and Image formation

Introduction and Goals of Computer Vision, Image formation: Geometric transformations, Geometric Camera Models, Single camera setup of image formation. Image formation in a stereo vision setup, Photometric image formation, The digital camera

Unit- II : Fundamentals of Image Processing

Concepts Image enhancement : Contrast enhancement ,image filtering , Image transforms , colour models and transformations, Introduction to image segmentation

Unit –III : Image Descriptors and Features

Points and patches, Edges and contours, Lines and vanishing points, Texture Descriptors, Colour Features, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Scale Invariant Feature Transform.

Unit IV: Overview of Deep Learning

Supervised learning, Unsupervised learning, Deep neural networks, Convolutional neural networks, Model zoos, complex models.

Unit V: Motion Estimation and Depth estimation

Translational alignment, Parametric motion, Optical flow, Layered motion, Epipolar geometry, Sparse correspondence, Dense correspondence Dense correspondence, Multi-view stereo, 3D reconstruction

Unit VI : Applications of Computer Vision

Object detection and tracking , Semantic segmentation (Medical Image Segmentation, Video understanding, Vision and language, Face and Facial Expression Recognition, Image Fusion, Geasture recognition.

Text Books :

1. Szeliski, Richard. *Computer vision: algorithms and applications*. Springer Nature, 2022.

2. M.K. Bhuyan , " Computer Vision and Image Processing: Fundamentals and Applications", CRC Press, USA, ISBN 9780815370840 - CAT# K338147.

Reference Books:

7. Forsyth & Ponce, "Computer Vision-A Modern Approach", Pearson Education.
8. Multiple View Geometry in Computer Vision: R. Hartley and A. Zisserman, Cambridge University Press.

IOEUA40204D: Business Intelligence (Open Elective – III)

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): - Practical (P): -	20	20	20	40	-	-	100

Prerequisite: Readers/students are expected to know the following concepts:

5. Data Structures

Course Objectives:

- To study and understand the importance of Business Intelligence and need of data preparation for Business Intelligence.
- To study and understand the different components of analytics landscape and project cycle aligned with these components
- To study and understand different data transformations, data modelling steps and visualize the data on the data models
- To study and understand the ways of adding custom calculations needed and understanding the applications of different statistical concepts.
- To study and understand the BI deployments, administration cycle of BI implementations using Power BI

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Interpret the importance of Business Intelligence and need of data preparation for Business Intelligence (Apply level)
2. Identify, describe, relate to the concepts of different components of analytics landscape and project cycle aligned with these components.(Analyse Level)
3. Design and develop different data transformations, data models, analyse and visualize the data.(Create).
4. Design and develop custom calculations based on business and technical needs and demonstrate and implement different statistical concepts (Create)
5. To compare and interpret Author BI deployments, BI environments.(Analyse)
6. Describe and compare industrial BI implementations, use cases and current and future trends.(Analyse)

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Unit I:	**Need Of Analytics And Data Preparation**
Introduction to Analytics: What is Analytics?, Need of Analytics, Why Microsoft Power BI?, Types of Business Analytics **Data Sources:** Data Collection, Transactions Entry, Organizational Systems, Data Sources and Data Source Categories, Issues in Data and Need of Data Preparation **Need of Data Preparations:** What is Data Preparation?, Joining data, Appending Data, New Calculations, Removing Inconsistencies, Transposing **Setting up Power BI:** Installation and configuration of Power BI Desktop, Setup of required connector	
Unit II:	**Data Landscape And Project Cycle**

Understanding Data and Databases: What is a database?, What is a DBMS?, What is SQL?, What are tables?, Organization of tables in databases, Types of Data, Database Keys, Relationships between tables, Joins and Unions, Cross-database Joins, Type of Data: Structured, Unstructured and Semi-structured data **Data Architecture:** BI Architecture, Data Security and Governance, Administration **Analytics Project Lifecycle:** Requirements Understanding, Data Understanding, Wireframes, Data Preparation, Data Visualization, Deployment, Documenting, Project Team and Roles, Challenges in Projects	
Unit III:	**Data Modelling And Visualization**
Data Integration and Data Warehouses: What is Data Integration?, Need of Data Integration, ETL, What is Data Warehouse?, Need of Data Warehouse, Facts and Dimensions , Star Schema and Snowflake Schema, Data Marts **Data Transformation [Basics]:** Merging and Appending Data, Filtering, Cleaning Data, Fixing Errors, Transforming Data, Aggregating Data **Data Modelling:** Setting Relationships, Creating Data Models **Data Visualization:** What are KPIs?, Dashboards, Reports and Scorecards, Types of Dashboards, Slicers and Filters, Setting interactivity, Creating Hierarchies, Groups, Drilldowns and Drill-through, Formatting your visualizations, Best practices of visualizations, Aggregations: SUM, MAX, AVG, MIN	
Unit IV :	**Custom Calculations And Analytics**
Data Transformations [Advanced]: Tabular Model at database level, Cross-database joins **Calculations:** Calculated Fields, Calculated Measures, Time-intelligent Functions, Moving Averages and Running Total, What-if Analysis, Conditional formatting **Statistical Analytics:** Mean, Mode, Median, Variance and Standard Deviation,Simple Regression, Multiple Regression	
Unit V :	**Power BI Deployment, Administration And Mobility**
Power BI Deployment: Overview of Power BI Service, Publishing to Power BI Service. Understanding the Power BI Service Workspaces, Apps, Creating Dashboards in Power BI Service, Subscriptions, Comments and Data Driven Alerts, Authoring reports within Power BI Service, Sharing dashboards across your organization, Configuring Gateways, Scheduling automated refresh of your reports using Data Gateway **Power BI Advanced Features:** Using NLP to creating dashboards, Influencers, Delivering Insights, Explain Analysis **Mobile Analytics:** Creating Dashboards for Mobiles, Using dashboards and reports using Mobile App	
Unit VI :	**Industry Analytics Landscape**
Working with Tableau: Introduction to Tableau, Installation and Setup of Tableau Desktop, Visualizing with Tableau **Advanced Concepts:** Web Analytics, Sentiment Analysis, Big Data, Data Lakes, IoT **Applications of Business Analytics:** Manufacturing Use Cases, EPC Use Cases, Retail Use Cases, Future Trends of Analytics	

Text Books :

1. "Business Intelligence Guidebook: From Data Integration To Analytics" by Rick Sherman, Elsevier Inc.
2.Successful Business Intelligence, Second Edition: Unlock The Value Of BI & Big Data" by Cindi Howson, McGraw Hill Edition
3"Data Analytics For Beginners: Your Ultimate Guide To Learn And Master Data Analysis. Get Your Business Intelligence Right – Accelerate Growth And Close More Sales" by Victor Finch
4. Data Strategy: How To Profit From A World Of Big Data, Analytics And The Internet Of Things" by Bernard Marr, Koganpage Publicaitons, Auva Press

Reference Books:

9. "Performance Dashboards – Measuring, Monitoring, And Managing Your Business" by Wayne Eckerson, John Wiley & Sons, Inc
10. "Business Intelligence Roadmap: The Complete Project Lifecycle For Decision-Support Applications" by Larissa T. Moss & Shaku Atre, Addison-Wesley information Technology Series
11. "Artificial Intelligence: Building Intelligent Systems" by Dr. Parag Kulkarni, Dr. Prachi Joshi, PHI publication (for understanding of concepts)

ETUA40505:Research Methodology and IPR

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): - Practical (P): -	--	--	50	--	--	--	50

Course Objectives:

- Explain the formulation of Research Problem
- Explain the importance of ideas, concept and creativity.
- Transfer the knowledge about the IPR required for Engineer's.
- Describe the how IPR creates National wealth.
- Teach National and International IP System

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Formulate the research problem with appropriate objectives.
2. Understand the right of ownership, scope of protection as well as the ways to create and to extract value from IP and identify different types of Intellectual Properties(IPs)
3. Discover how IPR are regarded as a source of national wealth and mark of an economic leadership in context of global market scenario.
4. Analyze national & International IP system.

Unit I : Introduction to Research problem

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research Problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations, Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit II: Introduction to Intellectual Property

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights Understanding the types of Intellectual Property Rights:-Patents, Designs, Trademarks (Registered and unregistered trademarks), Copyright, Traditional Knowledge, Geographical Indications, Trade Secrets, Idea Patenting, (Case Studies)

Unit III: Introduction to Patents

New Developments in IPR, Process of Patenting and Development: Technological research, Innovation, patenting, development, International Scenario: WIPO, TRIPs, Indian Patent Office and its Administration.

Unit IV : Patent Acts and Licensing

Administration of Patent System–Patenting under Indian Patent Act, Patenting under PCT, Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non Provisional Patent Application and Specification

Text Books :

1. Resisting Intellectual Property by Halbert,Taylor & Francis Ltd, 2007.
2. Industrial Designby May all,Mc GrawHill.
3. Intellectual Property in New Technological Age by Robert P. Merges, Peter S.Menell,MarkA.Lemley

Reference Books :

1. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
2. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
3. Intellectual Property Rights under WTO by T. Ramappa, S. Chand
4. Introduction to Design by Asimov, Prentice Hall