Bharatiya Vidya Bhavan's
**Sardar Patel Institute of Technology**
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

**B. Tech. ETRX**

# B. Tech. (Electronics Engineering)

# Syllabus
# (Semester VII-VIII)

# 2020 Iteration (w.e.f. 2022-2023)

Bharatiya Vidya Bhavan's

# Sardar Patel Institute of Technology

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## B. Tech. ETRX

## 2020 ITERATION: ELECTRONICS DOMAIN

**Nomenclature of the Courses**

| | | | |
|---|---|---|---|
| **BSC** | Basic Science Course | **PC** | Program Core |
| **BSE** | Basic Science Elective | **PE** | Program Elective |
| **ESC** | Engineering Science Course | **MLC** | Mandatory Learning Course |
| **ESE** | Engineering Science Elective | **SCOPE** | Skill Certification for Outcome based Professional Education |
| **SBC** | Skilled Based Course | **OE** | Open Elective |
| **ABL-SATVA** | Self- Accomplishment Through Various Activities | **HSSE** | Humanities and Social Science Elective |
| **ABL-SEVA** | Social Empowerment Through Various Activities | | |

**Abbreviations**

| | | | |
|---|---|---|---|
| L | Lecture Hour | O | Other Work (Self Study) |
| T | Tutorial Hour | E | Total Engagement in Hours |
| P | Laboratory Hour | C | Credit Assigned |

| **Semester VII** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Type** | **Code** | **Course** | **L** | **T** | **P** | **O** | **E** | **C** |
| 1 | OE | OEXXX | OE-II | 2 | - | 2 | 3 | 7 | 3 |
| 2 | OE | OEXXX | OE-III* | 2 | - | 2 | 3 | 7 | 3 |
| 3 | PE | ET4X3 | PE | 3 | -- | -- | 5 | 8 | 3 |
| 4 | PE | ET4X4 | PE | 3 | -- | -- | 5 | 8 | 3 |
| 5 | SBC | ET401 | Main Project Stage-I | -- | -- | -- | -- | -- | 2 |
| 6 | ABL | SV4X/ST4X | SEVA-IV/SATVA-IV | - | - | - | - | 4 | 2 |
| 7 | S/M/H | SC4X/MN4X/HOXX | SCOPE-IV/Minor-IV/Honors-I | - | - | - | - | - | 3 |
| **TOTAL** | | | | | | | | | 16 |
| *OE-III must be from Basic Science Elective or Engineering Science Elective | | | | | | | | | |

| **Semester VIII (Option A : Cat1/Cat2)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Cat 1- For Students who have NOT preferred semester long internship** | | | | | | | | | |
| **No.** | **Type** | **Code** | **Course** | **L** | **T** | **P** | **O** | **E** | **C** |
| 1 | OE * | OEHXX | OE-IV | 2 | - | 2 | 3 | 7 | 3 |
| 2 | PE | ET4X5 | PE-III | 3 | -- | -- | 5 | 8 | 3 |
| 3 | PE | ET4X6 | PE-IV | 3 | -- | -- | 5 | 8 | 3 |
| 4 | SBC | ET402 | Main Project Stage-II | - | - | - | - | 12 | 6 |
| 5 | ABL | SV4X/ST4X | SEVA-IV/SATVA-IV | - | - | - | - | 04 | 2 |
| 6 | H | HOXX | Honors-II | - | - | - | - | - | 3 |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *May be taken from MOOCs, Essentially Humanities, Management related | | | | | | | | | |
| | | | | | | | | **TOTAL** | **17** |
| **Sem VIII (Option B : Only for Cat-1 Students)** | | | | | | | | | |
| **No.** | **Type** | **Code** | **Course** | **L** | **T** | **P** | **O** | **E** | **C** |
| 2 | SBC | ET403 | Main Project Stage-II | - | - | - | - | 36 | 16 |
| 3 | ABL | SV4X/ST4X | SEVA-IV/SATVA-IV | - | - | - | - | 04 | 1 |
| 4 | H | HOXX | Honors-II | - | - | - | - | - | 3 |
| *May be taken from MOOCs, Essentially Humanities, Management related | | | | | | | | | |
| | | | | | | | | **TOTAL** | **17** |

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# Semester-VII

# B. Tech. ETRX

| Course (Category) Code | Course Name | Teaching Scheme (Hrs/week) | | | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | O | E | L | T | P | Total |
| PE-III | Real Time Operating Systems | 2 | -- | 2 | 5 | 9 | 2 | -- | 1 | 3 |
| | | Examination Scheme | | | | | | | | |
| | | Component | ISE | | MSE | | ESE | | | Total |
| ET413 (1T13) | | Theory | 50 | | 50 | | 100 | | | 200 |
| | | Laboratory | 50 | | -- | | 50 | | | 100 |

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | ET201: Computer Architecture and Organization<br>ET206: Microcontrollers<br>IT12: Embedded System |
| **Course Objective:** To impart students the fundamentals of Operating Systems and provide the knowledge on the implementation aspects of real time concepts. | |
| **Course Outcomes (CO):** After successful completion of the course, student will be able to | |
| CO1 | Demonstrate the basic concept of OS and configure the System. |
| CO2 | Analyze different types of scheduling algorithms with given application |
| CO3 | Apply kernel Services and Synchronization |
| CO4 | Evaluate memory management strategies |

**CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | | | | 2 | | 2 | | |
| CO2 | 2 | 2 | 2 | 3 | | | | 2 | | 2 | | |
| CO3 | 2 | 2 | 2 | 3 | | | | 2 | | 2 | | |
| CO4 | 2 | 2 | 2 | 3 | | | | 2 | | 2 | | |

**CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| CO | PEO1 | PEO2 | PEO3 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|
| CO1 | | | | | | |
| CO2 | | 1 | 1 | | | |
| CO3 | | 1 | 1 | | | |
| CO4 | | 1 | 1 | | | |

# B. Tech. ETRX

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

| Remember · | Understand · | Apply · | Analyze · | Evaluate | Create |
|---|---|---|---|---|---|

**Theory Component**

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1 | Title | **OS Fundamentals** | | 06 |
| | 1.1 | Operating system objectives and functions, Evolution of OS, Characteristics of modern OS | 1,2 | |
| | 1.2 | Basic concepts: Task, Processes, Files, System calls, Shell, I/O management, Architecture of OS (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures) | 1,2 | |
| | 1.3 | Batch, Multi programming, Multitasking, Multiuser, parallel, distributed & real –time O.S | 1,2 | |
| | 1.4 | Real time issues, soft and hard real time services | 4,5 | |
| 2 | Title | **Scheduling** | | 08 |
| | 2.1 | Need of scheduling, Scheduling algorithms: FCFS, SJF, Priority, Round Robin, RMS | 4,5 | |
| | 2.2 | UNIX Multi-level feedback queue scheduling, Thread Scheduling, Multiprocessor Scheduling concept | 3 | |
| 3 | Title | **Task / Process Management** | | 08 |
| | 3.1 | Concurrency: Principles of Concurrency, Mutual Exclusion, H/W Support, software approaches, Semaphores and Mutex, Message Passing techniques | 4,5 | |
| | 3.2 | Deadlock: Principles of deadlock, Deadlock Detection, Deadlock Prevention, Deadlock Avoidance, An Integrated Deadlock Strategies. | 4,5 | |
| 4 | Title | **Memory Management** | | 06 |
| | 4.1 | Memory Management requirements, Memory partitioning: Fixed, dynamic partitioning | 2,3 | |
| | 4.2 | Memory allocation Strategies (First Fit, Best Fit, Worst Fit, Next Fit), Fragmentation, Swapping, Segmentation, Paging, Virtual Memory, Demand paging | 2,3 | |
| | 4.3 | Page Replacement Policies (FIFO, LRU, Optimal, clock),Thrashing, Working Set Model | 2,3 | |
| 5 | Self Study | **Case Studies** | | |
| | 5.1 | Comparison and study of RTOS: RTLinux, Vxworks, µCOS and FreeRTOS | 3,4, 6, 7 | |
| | 5.2 | RTOS for Industrial Control System (ICS) | | |
| | | | **Total** | **28** |

**Laboratory Component**

| Sr. No. | Title of the Experiment* |
|---|---|
| 1 | Basic commands of LINUX, User management and Booting process |
| 2 | Process management in LINUX |
| 3 | Advanced bash Shell scripting in LINUX |
| 4 | Memory management in LINUX |
| 5 | Configure network interface in LINUX |
| 6 | Comparing Foreground background and Task management system in µCOS/ FreeRTOS |
| 7 | Scheduling of Task in µCOS/ FreeRTOS |
| 8 | Task Synchronization using semaphores in µCOS/ FreeRTOS |
| 9 | Resource protection using mutex in µCOS/ FreeRTOS |
| 10 | Task Synchronization using message queue and mailbox in µCOS/ FreeRTOS |

**Reference Books**

| Sr. No. | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| 1 | Operating Systems: Internals and Design Principles | 8th Edition | William Stallings | Pearson | |
| 2 | Modern Operating System | 4th Edition | Andrew S. Tanenbaum, Herbert Bos | Pearson | |
| 3 | The Design of the UNIX Operating System | | Maurice J. Bach | Prentice Hall | |
| 4 | Embedded System: Architecture, Programming and Design | | Rajkamal | Tata McGraw-Hill Education | 2011 |
| 5 | Introduction to Embedded Systems | | Shibu K. V. | Tata McGraw-Hill Education | 2017 |
| 6 | Mastering the FreeRTOS™ Real Time Kernel, A Hands-On Tutorial Guide | | Richard Barry | | 2016 |
| 7 | MicroC/OS-II: The Real Time Kernal | | Jean J. Labrosse | CRC press | 05 Feb 2002 |

## B. Tech. ETRX

| Course (Category) Code | Course Name | Teaching Scheme (Hrs/week) | | | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | O | E | L | T | P | Total |
| PE | Analog CMOS VLSI Design | 3 | -- | -- | 5 | 8 | 3 | -- | -- | 3 |
| | | Examination Scheme | | | | | | | | |
| | | Component | ISE | | MSE | | ESE | | | Total |
| ET414 (1T14) | | Theory | 75 | | 75 | | 150 | | | 300 |
| | | Laboratory | -- | | -- | | -- | | | -- |

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | ET101: Basic Electrical Engineering<br>EC101: Digital Systems and Microprocessors<br>ET202: Electronic Devices<br>ET205: Analog Circuits<br>PE-1T11: Digital CMOS VLSI Design |
| **Course Objective:** This primary goal of this course is to impart knowledge related to basic building blocks of CMOS analog circuits. This course will make students aware of technological challenges offered by scaled technologies coupled with multiple trade-offs in analog design. This course is expected to build analytical skills related to CMOS analog design among the students. Knowledge of fundamentals of MOSFET and CMOS Digital VLSI design is a must to understand this course in a better manner. | |
| **Course Outcomes (CO):** After successful completion of the course, student will be able to | |
| **ET414.1** | Recognize trade-offs involved in analog VLSI Circuits |
| **ET414.2** | Analyze current mirrors and bandgap references |
| **ET414.3** | Analyze single stage amplifier using small signal model as well as large signal methodology |
| **ET414.4** | Analyze MOSFET based differential and operational amplifier |

**CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ET414.1 | 3 | | | | | | | | | | | |
| ET414.2 | | 3 | | | | | | | | | | |
| ET414.3 | | 3 | | | | | | | | | | |
| ET414.4 | | 3 | | | | | | | | | | |

# B. Tech. ETRX

**CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| | PEO1 | PEO2 | PEO3 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|
| **ET414.1** | 1 | 2 | 2 | | | |
| **ET414.2** | 1 | 2 | 2 | | | |
| **ET414.3** | 1 | 2 | 2 | | | |
| **ET414.4** | 1 | 2 | 2 | | | |

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

| Remember · | Understand · | Apply · | Analyze · | Evaluate | Create |
|---|---|---|---|---|---|
| | | | | | |

**Theory Component**

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| **1** | **Title** | **CMOS analog building blocks** | 1 | **08** |
| | **1.1** | Necessity of CMOS analog design | | |
| | **1.2** | **MOS Models:** Structure of MOSFET, Review of characteristics of MOS device, Second order effects, MOS small signal model, MOS spice models | | |
| **2** | **Title** | **Current Mirrors and Bandgap References** | 1 | **08** |
| | **2.1** | **Passive and Active Current Mirrors:** Basic current mirrors, Cascode current mirrors and Active current mirrors | | |
| | **2.2** | **Band Gap References:** General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing | | |
| **3** | **Title** | **Single Stage Amplifiers** | 1 | **10** |
| | **3.1** | Basic concepts, Common source stage: resistive load, diode-connected load, current-source load, triode load and source degeneration | | |
| | **3.2** | Source follower, Common gate stage, Cascode stage | | |
| **4** | **Title** | **Differential Amplifiers** | 1 | **06** |
| | **4.1** | Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads and Gilbert cell | | |
| **5** | **Title** | **MOS Operational Amplifiers** | 1,2,3 | **10** |

| | | | | |
|---|---|---|---|---|
| | **5.1** | **Op-amp:** General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations, Slew Rate, Power supply rejection | | |
| | **5.2** | **Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps | | |
| | | | **Total** | **42** |

**Reference Books**

| Sr. No. | Title | Edition | Author | Publisher | Year |
|---|---|---|---|---|---|
| 01 | Design of Analog CMOS Integrated Circuits | 1st Edition | B Razavi | Tata McGraw Hill | 2017 |
| 02 | CMOS Circuit Design, Layout, and Simulation | Student Edition | R. Jacaob Baker, Harry W. Li, David E. Boyce | Wiley | 2009 |
| 03 | CMOS Analog Circuit Design | 3rd Edition | P. E. Allen and D. R. Holberg | Oxford University Press | 2016 |

# B. Tech. ETRX

| Course (Category) Code | Course Name | Teaching Scheme (Hrs/week) | | | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | O | E | L | T | P | Total |
| PE- III | Image and Video Processing | 2 | - | 2 | 5 | 8 | 2 | - | 1 | 3 |
| | | Examination Scheme | | | | | | | | |
| ET423 (1T23) | | Component | ISE | | MSE | | ESE | | | Total |
| | | Theory | 50 | | 50 | | 100 | | | 200 |
| | | Laboratory | 50 | | -- | | 50 | | | 100 |

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | EC207: Signals and Systems<br>EC303: Digital Signal Processing |
| **Course Objective:** To study the image and video fundamentals and mathematical transforms necessary for processing and enhancement techniques. To study image restoration procedures and compression procedures for different applications. | |
| **Course Outcomes (CO):** ***At the end of the course students will be able to*** | |
| ET423.1 | Apply the image fundamentals and mathematical models for digital image and video processing. |
| ET423.2 | Analyze time and frequency domain techniques for image enhancement. |
| ET423.3 | Apply segmentation and compression techniques. |
| ET423.4 | Develop image and video processing applications. |

**CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ET423.1 | 3 | 3 | | | | | | | | | | |
| ET423.2 | | | 3 | 2 | 3 | | | | | | | 2 |
| ET423.3 | | | | | 3 | | | | | | | |
| ET423.4 | 2 | 2 | | | 3 | 2 | | | 3 | 3 | | 3 |

**CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| | PEO1 | PEO2 | PEO3 | PEO4 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|
| ET423.1 | | 2 | | | | | |
| ET423.2 | | | | | 3 | | |
| ET423.3 | | | 2 | | | | |
| ET423.4 | | | 2 | | | 3 | |

# B. Tech. ETRX

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

| Remember | Understand | Apply · | Analyze · | Evaluate · | Create |
|---|---|---|---|---|---|

**Theory Component**

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1 | Title | **Fundamental of Image and Video** | 1,6 | 04 |
| | 1.1 | Structure of the Human Eye, Light, Brightness adaption and discrimination, Pixels, coordinate conventions, | | |
| | 1.2 | Imaging Geometry, Image acquisition, sampling and quantization, image resolution, basic relationship between pixels, colour images, RGB, HSI and other models | | |
| 2 | Title | **Two Dimensional Transforms and Image Enhancement** | 1,5 | 06 |
| | 2.1 | Discrete Fourier Transform, Discrete Cosine Transform, KL Transform, and Discrete Wavelet Transform | | |
| | 2.2 | Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, smoothing filters, sharpening filters, gradient and Laplacian, Frequency domain filtering. | | |
| 3 | Title | **Image Segmentation and Compression** | 1,5 | 05 |
| | 3.1 | Point, line and edge detection, edge linking using Hough transform and graph theoretic approach, thresholding, and region-based segmentation, Morphological operations. | | |
| | 3.2 | JPEG and MPEG compression standard, H.265 video compression standard | | |
| 4 | Title | **Image Restoration** | 1,6 | 04 |
| | 4.1 | Basic Framework, Image degradation model, Noise characterization, Noise restoration filters, | | |
| | 4.2 | Adaptive filters, and Estimation of Degradation functions, Restoration Techniques. | | |
| 5 | Title | **Video Formation and Representation** | 2,3 | 05 |
| | 5.1 | Digital Video Sampling, Video Frame classifications, I, P and B frames, Notation | | |
| | 5.2 | Video Capture and display: Principle of color video camera, video camera, digital video Sampling of video Signals: Required sampling rates, sampling in two dimensions and three dimensions, progressive virus interlaced scans | | |
| 6 | Title | **Motion Estimation** | 2,3 | 04 |
| | 6.1 | Optical Flow: Motion Vs optical flow, optical flow equations, motion representation, motion estimation criteria, optimization | | |

| | | | | |
|---|---|---|---|---|
| | | method. | | |
| | **6.2** | Pixel based motion estimation, Block Matching Algorithms, Multi resolution Motion Estimation: General formulation. | | |
| **7** | **Self-Study** | Study of different format of image and video, Basics of image and video terminology, ITU-RBT 601, Digital Video formats, Digital video quality measure. | | |
| | | | **Total** | **28** |

**Laboratory**:

| Sr. No | **Title of the Experiment** |
|---|---|
| 1. | Image Enhancement |
| 2. | Image Transformations. |
| 3. | Image Filtering |
| 4. | Image Segmentations |
| 5. | Image Compression |
| 6. | Image Restoration |
| 7. | Object Detection in video |
| 8. | Motion Estimation on video |
| 9. | Color Image Segmentation |
| 10. | Discrete Wavelet Transforms on image |

**Textbook**

| **Sr. No** | **Title** | **Edition** | **Authors** | **Publisher** | **Year** |
|---|---|---|---|---|---|
| 1 | Computer Vision and applications-A Guide for Students and Practitioners | First | Bernd Jahne and Host HauBecker | Elsevier | -- |
| 2 | Digital Image and Video Processing | First | Dhananjay Theckedath | Pearson Education | 2019 |

**Reference Books**

| **Sr. No** | **Title** | **Edition** | **Authors** | **Publisher** | **Year** |
|---|---|---|---|---|---|
| 1 | Digital Image Processing | Third | Rafael C. Gonzalez and Richard E. Woods | Pearson Education | 2010 |
| 2 | Digital Video Processing | Second | Murat Tekalp | Pearson Education | 2010 |
| 3 | Handbook on Image and Video Processing | --- | A.I.Bovik | Academic Press | 2009 |

## B. Tech. ETRX

| Course (Category) Code | Course Name | Teaching Scheme (Hrs/week) | | | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | O | E | L | T | P | Total |
| PE | Principles of Soft Computing | 2 | 0 | 2 | 6 | 8 | 2 | 0 | 1 | 3 |
| | | Examination Scheme | | | | | | | | |
| | | Component | ISE | | MSE | | ESE | | | Total |
| EC424 | | Theory | 50 | | 50 | | 100 | | | 200 |
| | | Laboratory | 50 | | -- | | 50 | | | 100 |

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | MA101: Engineering Calculus<br>MA102: Differential Equations and Complex Analysis |
| **Course Objective:** To implement soft computing-based solutions for solving real-world problems | |
| **Course Outcomes (CO):** ***At the end of the course students will be able to*** | |
| EC424.1 | Identify soft computing techniques and their roles in building intelligent Machines. |
| EC424.2 | Apply fuzzy logic reasoning to build model for solving various engineering problems. |
| EC424.3 | Analyze optimization issues using Genetic Algorithm. |
| EC424.4 | Design various hybrid soft computing models by using different techniques . |

**CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EC424.1 | 2 | 2 | | | 3 | | | | | | | |
| EC424.2 | | 2 | 2 | | 3 | | | | | | | |
| EC424.3 | | | 2 | | 3 | | | | | | | |
| EC424.4 | | | | 2 | 3 | | | | | | | |

**CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

| | PEO1 | PEO2 | PEO3 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|
| EC424.1 | 2 | | | 2 | 2 | |
| EC424.2 | 2 | | | 2 | 2 | |
| EC424.3 | 2 | | | | 2 | |
| EC424.4 | | 3 | | | 2 | 3 |

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

| Remember | Understand | ✓ Apply | ✓ Analyze | ✓ Evaluate | Create |
|---|---|---|---|---|---|

# B. Tech. ETRX

**Theory Component**

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1 | **Title** | **Introduction To Soft Computing and Neural Networks** | 1,2 | **04** |
| | **1.1** | Introduction to Soft Computing, Difference between Hard and Soft Computing. Conventional AI, Computational Intelligence | | |
| 2 | **Title** | **Neural Networks** | 1,2 | **10** |
| | **2.1** | Biological neuron, Artificial Neuron Model, Single layer Multilayer Architecture of Neural Networks Architecture, Activation functions, Learning rules. | | |
| | **2.2** | Supervised Learning Neural Network: Back Propagation Network, Radial Basis Function Network. | | |
| | 2.3 | Unsupervised Learning Neural Network: Adaptive Resonance Architecture. | | |
| 3 | **Title** | **Fuzzy Logic** | 3 | **6** |
| | **3.1** | Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations | | |
| | **3.2** | Membership Functions, Fuzzy Rules and Fuzzy Reasoning | | |
| | **3.3** | Fuzzy Inference Systems, Fuzzy Models. | | |
| 4 | **Title** | **Genetic Algorithm** | 3 | **8** |
| | **4.1** | Introduction to Genetic Algorithm, Working Principle of Genetic Algorithm. | | |
| | **4.2** | Various Encoding methods, Fitness function. | | |
| 5 | **Self-Study** | Analyse advanced soft computing techniques. | | |
| | | | **Total** | **28** |

**Laboratory Component**

| Sr. No | Title of the Experiment |
|---|---|
| **1** | Linear & Nonlinear analysis using single &multiplayer neural network |
| **2** | Supervised learning neural network |
| **3** | Unsupervised learning neural network |
| **4** | Fuzzy logic operations |
| **5** | Fuzzy system design |
| **6** | Genetic Algorithm |
| **7** | Design Neuro-fuzzy model |
| **8** | Hybrid Design/Expert system Design |

# B. Tech. ETRX

**Text Books**

| Sr. No | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| 1 | Introduction to Artificial Neural Systems | -- | Jacek M. Zurada | PWS Publishing Company | 1995 |
| 2 | Principles of Soft Computing | Third | S.N.Sivanandam and S.N.Deepa | Wiley Publication, | 2018 |
| 3 | Neural Networks, Fuzzy Logic and Genetic Algorithms | -- | S.Rajasekaran and G. A. Vijayalakshami | Prentice-Hall of India | 2004 |

**Reference Books**

| Sr. No | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| 1 | Neural Networks: A Comprehensive Foundation | -- | Simon Haykin | Macmillan College Publishing Company | 1994 |
| 2 | Neural Network Design | -- | Martin Hagan | CENGAGE Learning, India | 2008 |
| 3 | Fuzzy Sets and Fuzzy Logic: Theory and Applications | -- | George J. Klir and Bo Yuan | Prentice-Hall of India | 1994 |

## B. Tech. ETRX

| Course (Category) Code | Course Name | Teaching Scheme (Hrs/week) | | | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | O | E | L | T | P | Total |
| PE | Networking Fundamentals (@) | 2 | - | 2 | 3 | 7 | 2 | - | 1 | 3 |
| | | Examination Scheme | | | | | | | | |
| ET425 | | Component | ISE | | MSE | | ESE | | | Total |
| | | Theory | 50 | | 50 | | 100 | | | 200 |
| | | Laboratory | 50 | | -- | | 50 | | | 100 |

**@--> Not to be repeated if already studied as a Programme Core i.e. Computer Communication Networks**

| **Pre-requisite Course Codes, if any.** | ET301: Analog and Digital Communication |
|---|---|
| **Course Objective:** | |
| **Course Outcomes (CO):** At the end of the successful completion of the course students will be able to | |
| ET425.1 | Identify network topologies, physical devices and standards |
| ET425.2 | Recognize the significance of multiple layers of the OSI model in networking environment. |
| ET425.3 | Solve network issues by using IP addressing concepts. |
| ET425.4 | Examine the current challenges in computer security and identify possible solutions to resolve the same. |

**CO-PO Correlation Matrix: (1-Weak, 2-Medium 3-Strong)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ET425.1 | 3 | 3 | | | | | | | | | | |
| ET425.2 | | | 3 | 2 | 3 | | | | | | | 2 |
| ET425.3 | | | 3 | | 3 | 2 | | | | | | |
| ET425.4 | 2 | 2 | | | | | | | 3 | 3 | | 3 |

**CO-PEO/PSO Correlation Matrix: (1-Weak, 2-Medium 3-Strong)**

| | PEO1 | PEO2 | PEO3 | PEO4 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|
| ET425.1 | 2 | | | | | | |
| ET425.2 | | | | | | 2 | |
| ET425.3 | | | | | | 2 | |
| ET425.4 | 2 | | | | | 2 | |

# B. Tech. ETRX

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

| Remember · | Understand | Apply · | Analyze · | Evaluate · | Create |
|---|---|---|---|---|---|

**Theory Component**

| Module No. | Unit No. | Topics | CO | Ref. | Hrs |
|---|---|---|---|---|---|
| 1 | Title | **Introduction** | CO1 | 1,2 | 06 |
| | 1.1 | Topologies, LAN, MAN, WAN | | | |
| | 1.2 | Introduction to networking devices | | | |
| | 1.3 | Transmission Medias: Wired and Wireless network | | | |
| 2 | Title | **Reference Models** | CO2 | 1,2 | 06 |
| | 2.1 | Defining Networks with the OSI and TCP/IP Model | | | |
| 3 | Title | **IP addressing** | CO3 | 1,2 | 06 |
| | 3.1 | Working with IPv4: IP addressing schemes, Subnet Masks, Subnetting, Introduction to IPv6. | | | |
| 4 | Title | **Introduction to Network Security** | CO4 | 3 | 10 |
| | 4.1 | Introduction to Core Security Principles: Confidentiality, Integrity, Availability, Authentication. | | | |
| | 4.2 | Cryptography Threats: Malware Attacks, Social Engineering | | | |
| | 4.3 | Attacks, Networking-based and Server based Attacks | | | |
| 5 | Self Study | **Fairness algorithms, Congestion Control mechanisms.** | | | *03 |
| | | | | **Total (*Not included)** | 28 |

**Laboratory Component (Minimum 10 Laboratory experiments are expected)**

| Sr. No. | Title of the Experiment |
|---|---|
| 1 | Identify and observe the behaviour of networking command line tools in Ubuntu/Windows OS environment. |
| 2 | To build and test straight through UTP ethernet network cables. |
| 3 | Write a program in C/C++/Python/Java/Scilab to identify the IP address, Subnet mask, DNS server address and Hardware address of the client device. |
| 4 | Write a program in C/C++/Python/Java/Scilab to determine the administrators requirement to define the number of subnets, host/subnet, customized subnet masks and valid subnet ranges |

| | |
|---|---|
| | for a class C IP addressing scheme. |
| **5** | Examine Data Breaches and Scan for Malware Using the Microsoft Safety Scanner |
| **6** | Handson experience on how to Write-Protect and Disable a USB Flash Drive |
| **7** | Protocol Visualization with open source tools |
| **8** | Network Reconnaissance using open sourcetools |
| **9** | Web Reconnaissance Using a Web Browser/open source tools |
| **10** | Cryptography using open source tools/Crypt tools and open SSL |
| **11** | Install and configure application based server |

**Text Books**

| Sr. No. | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **1** | Data Communication and Networking | 4th | A.A. Forouzan | McGraw Hill | 2017 |
| **2** | Data and Computer Communications | 10th | William Stallings | Pearson Education | 2013 |
| **3** | Information Security: Principles and Practice | 1st | Deven Shah | Wiley | 2007 |

**Reference Books**

| Sr. No. | Title | Edition | Author | Publisher | Year |
|---|---|---|---|---|---|
| **1** | Computer Networking: A Top-Down Approach | 5th | J. F. Kurose and K. W. Ross | Pearson Education | 2009 |
| **2** | Computer Networks | 5th | A.Tanenbaum | Pearson Education | 2013 |
| **3** | Computer Networks: Protocols, Standards and Interface | 2nd | Uyless Black | Prentice Hall | 1993 |

# B. Tech. ETRX

| Course (Category) Code | Course Name | Teaching Scheme (Hrs/week) | | | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | O | E | L | T | P | Total |
| PE | Energy Storage Systems in EV Applications | 2 | - | 2 | 3 | 7 | 2 | - | 1 | 3 |
| | | Examination Scheme | | | | | | | | |
| ET433 | | Component | ISE | | MSE | | ESE | | | Total |
| | | Theory | 50 | | 50 | | 100 | | | 200 |
| | | Laboratory | 50 | | -- | | 50 | | | 100 |

**Objectives:**

(1) To learn the characteristics and specifications of major Energy storage apparatus being used and explored in EV Applications such as Batteries, Super-capacitors and Fuel Cell (2) To be able to analyze and design the commonly used Battery charger circuits for EV Applications (3) To know various national and international battery charging standards and protocols.

## Course Content:

**Module-1 Batteries and Fuel Cells**

Li-Ion Battery characterization and testing systems & Battery life cycle, Modular battery packs, design, packaging, thermal control and legislative implications. Super-capacitors : Materials and Construction, Basic Model, Specific Behavior of Supercapacitors, Hydrogen Generation and Storage of Hydrogen, Conversion from Hydrogen to Electricity, Power Needed for the Fuel Conditioning, Efficiency of the Fuel Cells, Overall Efficiency.

**Module-2: Battery Management System:**

Need of BMS, Concept of Battery Cell Balancing and strategies, Passive and Active cell Balancing circuits, BMS hardware Design, BMS hardware Protection, BMS Software Strategies, Intelligent Cell Balancing Algoritms, Monitoring and Protections, Charging and Discharging Management, Diagnostics and testing, Communication

**Module-3: Battery Charging Standards and Protocols:**

AC Charging: Bharat EV Charger AC-001, DC Charging : Bharat EV Charger DC-001, Home Charging: AC Charging with Single Phase 230V/15A supply, Public Charging AC-001: AC Charging with three Phase 415V AC supply Mains, Public Charging DC-001, Fast Charging for high voltage EVs: Combined charging system CCS-2 and CHAdeMo with ratings from 50kW to 150kW and DC voltages ranging from 400Vto 950V DC.

**Course Projects and Lab Work:**

(a) battery materials; (b) novel thermal management system for maintaining temperature uniformity among the cells and restrict the rise of maximum temperature above normal conditions; (c) Digital twin based on IoT; sensors; cloud computing; multi-physics modelling and machine learning for real-time monitoring of

SoC and SoH of batteries under dynamic discharge conditions;(d) aging controlled fast charging of batteries by evaluation of optimal charging current, and simultaneously optimizing charging time and capacity.

**References:**

1. Energy Storage by Robert A. Huggins, Springer Publication
2. Energy storage (A new approach) by Ralph Zito Wiley Publication
3. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, The Fairmont Press Inc., 7th Edition.
4. Energy Management Handbook, Wayne C. Turner, The Fairmont Press Inc., 5th Edition,Georgia.
5. Energy Storage Systems, Alfred Rufer, CRC Press

**Additional References:**

1. Z. Zhang, H. Gui, D. Gu, Y. Yang and X. Ren, "A Hierarchical Active Balancing Architecture for Lithium-Ion Batteries," in *IEEE Transactions on Power Electronics*, vol. 32, no. 4, pp. 2757-2768, April 2017.
2. M. Daowd, N. Omar, P. Van Den Bossche and J. Van Mierlo, "Passive and active battery balancing comparison based on MATLAB simulation," *2011 IEEE Vehicle Power and Propulsion Conference*, Chicago, IL, 2011, pp. 1-7.
3. M. Caspar, T. Eiler and S. Hohmann, "Systematic Comparison of Active Balancing: A Model-Based Quantitative Analysis," in *IEEE Transactions on Vehicular Technology*, vol. 67, no. 2, pp. 920-934, Feb. 2018.
4. Xiaoqiang Zhang†, Weiping Zhang, and Geyang Lei," A Review of Li-ion Battery Equivalent Circuit Models," in *TRANSACTIONS ON ELECTRICAL AND ELECTRONIC MATERIALS*, Vol. 17, No. 6, pp. 311-316, December 25, 2016
5. Min Chen, Student Member, IEEE, and Gabriel A. Rinc´on-Mora, Senior Member, IEEE," Accurate Electrical Battery Model Capable of Predicting Runtime and I–V Performance ",in*IEEE TRANSACTIONS ON ENERGY CONVERSION*, VOL. 21, NO. 2, JUNE 2006
6. Jian Cao, Nigel Schofield and Ali Emadi," Battery Balancing Methods: A Comprehensive Review ", in *IEEE Vehicle Power and Propulsion Conference* (VPPC), September 3-5, 2008

# B. Tech. ETRX

| Course (Category) Code | Course Name | Teaching Scheme (Hrs/week) | | | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | O | E | L | T | P | Total |
| PE | Power Electronic Converters in EV Applications | 2 | - | 2 | 3 | 7 | 2 | - | 1 | 3 |
| ET434 | | Examination Scheme | | | | | | | | |
| | | Component | | ISE | | MSE | | ESE | | Total |
| | | Theory | | 50 | | 50 | | 100 | | 200 |
| | | Laboratory | | 50 | | -- | | 50 | | 100 |

## Course Content:

**Module-1 Battery Chargers**

Types of EV Chargers, On board Chargers, DC Fast Chargers, PF Improvement strategies and Control, DC-DC Converter design and Control Scheme. Topology Selection, Control Method for Fast Charger, Charger Converter Hardware Design, Magnetics Design and Selection, Charger Converter Software Design, Enclosure and Connectors, Thermal Engineering.

**Module-2 EV Traction Drive and Control**
Motor Selection and types, Torque/Speed curve of different motor types and their comparison, Motor Inverter hardware Design, MOSFET/IGBT Selection, Gate Driver Circuit Design, Power Supply and Controller Hardware, Motor Inverter Software Strategies for control of BLDC Motor Drive and Induction Motor Drive,. Motor Inverter Thermal Engineering, Connectors and Wiring, Active and Passive Discharge (in case of DC Bus > 60V). EMI/EMC Standards Introductions

**Module-3: DC-DC converter Unit for EV Ancillary Power System**
Power Converter Topology Selection, Control Method for DC-DC converter, Hardware Design, Magnetics Design and Selection, DC-DC Converter Software Design, Enclosure and Connectors, Thermal Engineering, Active and Passive Discharge, EMI/EMC Standards Introductions

**Case Studies: (To be covered in Practical Session)**

Design and development of high-power density power electronics converters, onboard chargers, machines for electric vehicles, power train technology and various controllers for drives and converters. Development of various novel control algorithms for converters and motor drives

**References:**

1. Chang Liang Xia,"Permanent Magnet Brushless Dc Motor Drives and Controls" Wiley 2012.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2011.
3. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education, second Edition, 2003.
4. Dubey. G.K., "Thyristorised power controllers", New age International, New Delhi, 2002.
5. Bhimbhra P.S., "Power Electronics", Khanna Publishers, New Delhi, 2005
6. Miller. T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon

Press, Oxford, 1989.
7. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford, 1989.
8. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford,
9. Robert .L.Boylsted,and Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education,9th edition,2009.
10. David A Bell, "Fundamentals of Electronic Devices and Circuits", Oxford University Press, 2009.
11. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 2nd Edition, New Age International Publishers, 2003