Deccan Education Society's
Fergusson College (Autonomous)
Pune - 411004

Curriculum

as per guidelines of

NEP-2020

for

S. Y. M. Sc. (Electronic Science)

With effect from Academic Year

2025-2026

M.Sc. (Electronic Science) – Second Year

Semester	Paper Code	Paper Title	Credits
III	ELS601	Data Communication and Networking	4
	ELS602	Embedded Processors	4
	ELS603 OR ELS604	VLSI System Design Image Processing	4
	ELS610	Research Project- I	4
	ELS620	Electronics Practical-V	2
	ELS621	Electronics Practical-VI	2
	Total Semester- III Credits		20
IV	ELS651	Industrial Process Control	4
	ELS652	Internet of Things	4
	ELS653 OR ELS654	Electric and Hybrid Electric Vehicles Artificial Intelligence and Machine Learning	4
	ELS661	Research Project- II	6
	ELS670	Electronics Practical-VII	2
	Total Semester- IV Credits		20
Total PG-II Credits			40

Program Outcomes (POs) for M. Sc. Programme	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that form a part of postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	**Research-related skills and Scientific temper:** Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge**: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence**: Perform independently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics**: Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.

PO8	**Environment and Sustainability**: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes (PSOs) for M. Sc. Electronic Science	
PSO No.	**Program Specific Outcomes(PSOs)** **Upon completion of this programme the student will be able to**
PSO1	**Academic competence:** 1. Understand concepts and develop applications in the field of Semiconductor technology, Core electronics, Communication/ networking, Digital Electronics, Embedded systems and Automation. 2. Demonstrate, classify, calculate and execute real world problems by experimenting a wide range of solutions to real world problems in the field of Electronics.
PSO2	**Personal and Professional Competence:** 1. Design and implement the laboratory based applications with capability of data gathering, data visualization, analysis with data interpretation. 2. Prepare to collect and construct the data with the professional technical report writing skills along with precise presentation with effective communication skills and professional ethics.
PSO3	**Research Competence:** 1. Able to design and analyze the concepts and applications in the field of communication/ networking, automation, embedded systems and semiconductor technology. 2. Work successfully in collaborative and multi-disciplinary environments upholding professional and ethical values or pursuehigher studies or research.
PSO4	**Entrepreneurial and Social competence:** 1. Design techniques and provides creative, innovative and effective solutions to real world problems using hardware-software co-design tools for future smart electronics system 2. Develop effective communication skills in writing and orally; demonstrate the ability to listen carefully and present complex disciplinary information in a clear and concise manner to different groups.

S.Y. M. Sc. Semester III		
ELS-601	**Data Communication and Networking**	**Credits:** 4 **Hours:** 60

Course Outcome (COs): **On completion of the course, the students will be able to**	
CO1	Recall the facts about the physical arrangement of networks, types and modes of networks, data conversions and transmission medium
CO2	Understand the Basic emerging trends in computer networking
CO3	Apply the concepts of detection and correction of errors, link control and link protocols of data link layer
CO4	Analyse the performance of communication network
CO5	Evaluate different routing protocols and analyse their performance
CO6	Design and develop the different error control coding schemes

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Data Communication** **Data Communication**: Components of a Data Communication System, Simplex, Half Duplex and Duplex Modes of Communication **Computer Networks**: Network Topologies, Local Area Networks, Metropolitan Area Networks, Wide Area Network, Wireless Networks, Internet. **Network Models**: Layered Architecture, OSI Reference Model and its Protocols; TCP/IP Protocol Suite, Physical, Logical, Port and Specific Addresses. **Physical Layer**: Analog and Digital data, Analog and Digital signals, Digital Signals-Bit rate, Bit length, Baseband Transmission, Broadband Transmission, **Transmission Impairments**– Attenuation, Distortion and Noise. Data Rate Limits– Noiseless channel: Nyquist's bit rate, noisy channel: Shannon's law, Performance of the Network Bandwidth, Throughput, Latency (Delay), Bandwidth – Delay Product, Jitters, Line Coding Characteristics, **Line Coding Schemes**–Unipolar -NRZ, Polar-NRZ-I, NRZ-L, RZ, Manchester and Differential Manchester. **Transmission**	**12**

	Modes: Parallel Transmission and Serial Transmission– Asynchronous and Synchronous and Isochronous, Multiplexing FDM and TDM, Switching- Circuit Switching, Message Switching and Packet Switching.	
II	**Data Link Layer** **Framing** – Concept, Methods – Character Count, Flag bytes with Byte Stuffing, Starting and ending, Flags with Bit Stuffing, **Error detection code** – Hamming Distance, CRC **Elementary data link protocols** - Simplex stop and wait protocol, Simplex protocol for noisy channel, PPP, HDLC, **Sliding Window Protocols** – 1-bit sliding window protocols, Pipelining – Go-Back N and Selective Repeat, Random Access Protocols - ALOHA– pure and slotted, CSMA-1- persistent, p-persistent and non-persistent CSMA/CD, CSMA/CA. **Controlled Access** - Reservation, Polling and Token Passing, **Channelization** – Definitions – FDMA, TDMA and CDMA.	**16**
III	**Network Layer and Transport Layer** **IPv4 addresses**: Address space, Notation, Classful addressing, Classless addressing, NAT, Sub netting, Super netting. IPv4: Datagram, Fragmentation, checksum. **IPv6 addresses**: Structure, address space, IPv6: packet format, Extension headers. Process-to-Process Delivery, Multiplexing and De-multiplexing, User Datagram Protocol (UDP) - Datagram Format, Checksum, UDP operations, Use of UDP, Transmission Control Protocol (TCP) - TCP Services – Process to-Process, Communication, Stream Delivery Service, Sending and Receiving Buffers, Segments, Full-Duplex Communication, Connection oriented service, Reliable service, TCP Features – Numbering System, Byte Number, Sequence Number, Acknowledgement Number, Flow Control, Error Control, Congestion Control, TCP Segment Format, TCP Vs UDP	**16**

IV	**Application layer and Mobile Technology** World Wide Web (WWW): Uniform Resource Locator (URL), Domain Name Service (DNS), Resolution - Mapping Names to Addresses and Addresses to Names; Electronic Mail Architecture, SMTP, POP and IMAP; TELNET and FTP. **Mobile Technology**: GSM and CDMA; Services and Architecture of GSM and Mobile Computing; Middleware and Gateway for Mobile Computing; Mobile IP and Mobile Communication Protocol; Communication Satellites, Wireless Networks and Topologies; Cellular Topology, Mobile Ad hoc Networks.	**16**

Reference Books:

1. Behrouz A Forouzan, "Data Communications and Networking", McGraw-Hill, 3rd Edition, 2004.
2. Andrew S. Tanenbaum, "Computer Networks", Pearson Education/PHI, 4th Edition, 2003.
3. William Stallings, "Data and Computer Communication", Pearson Education Asia, 6th Edition.
4. Kurose and Ross, "Computer Networking", Pearson Education, 2002.
5. T. L. Marzetta, E. G. Larsson, H. Yang, and H. Q. Ngo, Fundamentals of Massive MIMO, Cambridge University Press, 2016
6. D. Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
7. R. S. Kshetrimayum, Fundamentals of MIMO Wireless Communications, Cambridge University Press, 2017
8. W. Xiang, K. Zheng, and X. Xuemin, 5G Mobile communications, Springer, 2017
9. J. Rodriguez, Fundamentals of 5G Mobile Networks, John Wiley and Sons, 2015
10. H. Yang and T. S. Quek, Massive MIMO meets Small Cell: Backhaul and Cooperation, Springer, 2016.

Online references: (NPTEL/ MOOC):

1. Link1: http://nptel.ac.in/courses/106105081.
2. Link2: http://nptel.ac.in/courses/106105082.
3. Link3: https://nptel.ac.in/courses/106/105/106105160/
4. Link4: https://www.netacad.com/courses/networking

S.Y. M. Sc. Semester III		
ELS -602	**Embedded Processors**	**Credits:** 4 **Hours:** 60

Course Outcome (COs): **On completion of the course, the students will be able to**	
CO1	Remember a basic knowledge about fundamentals of microcontrollers.
CO2	Understand the architectures of ARM7/ARM Cortex M4 Microcontrollers and its advantages over ARM 7 Microcontrollers.
CO3	Relate various Embedded Processor architectures related to industrial application.
CO4	Illustrate the programming of ARM7/ARM Cortex M4 based microcontrollers with on chip peripherals and external peripherals.
CO5	Evaluate the real world programming of ARM 7 based microcontroller with on chip peripherals and external peripherals.
CO6	Implement the interfacing of real world sensors, standard buses and develop embedded applications using different case studies.

Unit No.	Title of Unit and Contents	No. of Lectures
I	**ARM7 Based Microcontroller** ARM Embedded System RISC and ARM Design Philosophy, Embedded System Hardware and Software, ARM7 CPU Core, Processor Architecture (32-bit), ARM Programmer's Model, ARM Development Tools, Introduction to ARM families, ARM7TDMI Features, Pipelining, Exceptions, Interrupt Vector Table, ARM Instruction Set, Thumb Instruction, programming in assembly language. System Peripherals: Bus Structure, Memory Map, Register Programming	**12**
II	**Real World Interfacing with ARM7 Based Microcontroller**: ARM7 Based Microcontroller LPC2148 Features, architecture (block diagram and its description), system control block (PLL and VPB divider), memory map, GPIO, pin connect block, timer,	**16**

	interfacing with LED, LCD, GLCD, and KEYPAD.GSM and GPS using UART, on-chip ADC using interrupt (VIC), EEPROM using I2C, SDCARD using SPI, on-chip DAC for waveform generation	
III	**Introduction to ARM CORTEX M4 Based Microcontroller:** Introduction to ARM CORTEX series: CORTEX A, R, M processors, Firmware development using CMSIS Standard. Introduction to ARM CORTEX M4 microprocessor core, programmer model, Processor Modes, Memory Map, Introduction Arm Cortex-M cores, STM32F4xx Architecture, ARM STM Bus Architecture, STM32F4xx Clock and SYSCLK, Peripheral Clock, PLL clock, Interrupts and Exceptions in STM32F4xx.	**16**
IV	**Real World Interfacing with Cortex M4 Based Microcontroller** GPIO Programming, Interfacing seven segment LED, LDR and MQ3 sensor with STM32F4xx, STM32F4xx: Counters and Timers: Timer and Delay Generation, UART Programming, on chip ADC and On-chip DAC for waveform generation. Case Studies with Cortex M Based Microcontroller STM32F4xx Interfacing with accelerometer MPU 6050, Ultrasonic Sensor HC-SR04, PWM: Controlling speed and direction of DC Motor CAN Bus: Features, CAN Frame, sequence of transmitting and receiving data on CAN Bus.	**16**

Reference Books:

1. K.V. Shibu, “Introduction to Embedded Systems”, McGraw Hill Education India Private Limited, 2nd Edition
2. Andrew Sloss, Dominic Symes, Chris Wright, “ARM System Developer’s Guide – Designing and Optimizing System Software”, Elsevier, 1st Edition.
3. Shujen Chen, Muhammad Ali Mazidi, Eshragh Ghaemi, “STM32 Arm Programming for Embedded Systems: Using C Language with STM32”, Nucleo, Micro DigitalEd., Illustrated Edition,2018.
4. Steve Furber ARM System On Chip Architecture, Pearson.
5. Andrew Sloss, Dominic Symes and Chris Wright, ARM System Developers Guide – Designing and Optimizing System Software, , ELSEVIER.

6. The insider,,s guide to the PHILIPLS ARM7 based Microcontrollers, An Engineer Introduction LPC 214x User manual (UM10139): www.nxp.com
7. UM10139 LPC214x User manual, NXP Semiconductor
8. RM0390 Reference manual, STM32F446xx advanced Arm®-based 32-bit MCUs
9. Joseph Yiu, “The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors”, Newnes, 3rd Edition.

MOOC / NPTEL Courses:

1. NPTEL Course “ARM Based Development”, video course Link of the Course: https://nptel.ac.in/courses/117/106/117106111/
2. NPTEL Course on “ Embedded System Design with ARM”, video course Link of the Course: https://nptel.ac.in/courses/106/105/106105193/

S. Y. M. Sc. Semester III		
ELS-603	**VLSI System Design** **(Elective –I Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs): **On completion of the course, the students will be able to**		
CO1	Model the behaviour of a MOS Transistor	
CO2	Understanding CMOS Inverter	
CO3	Design combinational and sequential circuits using CMOS gates	
CO4	Identify the sources of power dissipation in a CMOS circuit	
CO5	Analyze SRAM cell and memory arrays	
CO6	Discuss applications of VLSI	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to VLSI Design**: Overview of VLSI Design: Historical perspective, overview of VLSI design methodologies, VLSI design flow, design hierarchy, concepts of regularity, modularity, and locality, VLSI design styles, design quality, packaging technology, CAD technology. **MOS Transistor Theory**: Introduction to the metal oxide semiconductor (MOS) structure, Long channel I-V characteristics, C-V characteristics, non-linear I-V effects, DC transfer characteristics.	**12**
II	**CMOS Process Technology**: Fabrication process flow- basic steps, the CMOS n-Well process, layout design rules, stick diagram, full-custom mask layout design. MOS Inverter (Static Characteristics): Resistive-load inverter, inverter with n-type MOSFET load, CMOS inverter. **MOS Inverters (Switching Characteristics and Interconnects effects)**: Delay-time definitions, calculation of delay times, logical efforts, inverter design with delay constraints, estimation of interconnect parasitic, calculation of interconnect delay, Bus vs. Network-on Chip (NoC), switching power dissipation of CMOS inverters.	**16**

III	**Combination CMOS Logic Circuits**: MOS logic circuits with depletion nMOS loads, CMOS logic circuits, complex logic circuits, CMOS transmission gates (pass gates), ratioed, dynamic and pass transistor logic circuits. **Sequential MOS logic circuits**: Behaviour of bi-stable elements, SR latch circuits, clocked latch and flip-flop circuits, CMOS D-latch and edge-triggered flip-flop. Timing path, Setup time and hold time static, example of setup and hold time static, setup and hold slack, clock skew and jitter, Clock, reset and power distributions.	**16**
IV	**Semiconductor Memories**: Memory Design, SRAM, DRAM structure and implementations. Introduction to ASIC and SoC, Overview of ASIC flow, functional verification, RTL-GATE level synthesis, synthesis optimization techniques, pre-layout timing verification, static timing analysis, floor-planning, placement and routing, extraction, post layout timing verification, extraction. **Recent Trends in VLSI Design & its research issues in industry**: System case studies. **Design automation of VLSI Systems**: basic concepts. Deep Sub-micron Technologies: Some Design Issues	**16**

Reference Books:

1. CMOS VLSI Design – A Circuits and Systems Perspective, Neil H.E. Weste, David Harris, Ayan Banerjee, , 3rd Edition, Pearson Education, 2006.
2. Principles of CMOS VLSI DESIGN: A Systems Perspective, Neil H. E. Weste , Kamran Eshraghian, 2nd Edition., Pearson Education, 2006.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Douglas A. Pucknell, Kamran Eshraghian, Basic VLSI Design, 3rd Edition., PHI,1994.
5. N. H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design : A Systems Perspective, Pearson Education.
6. W. Wolf, Modern VLSI Design: Systems on Silicon, Pearson Education.
7. J. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Prentice Hall of India.
8. M. Sarafzadeh and C. K. Wong, An Introduction to VLSI Physical Design, MCGraw-Hill.

S.Y. M. Sc. Semester III		
ELS-604	**Image Processing (Elective –II Theory)**	**Credits:** 4 **Hours:** 60 Hrs

Course Outcome (COs): On completion of the course, the students will be able to	
CO1	Understand the fundamentals of digital image formation and representation.
CO2	Analyze spatial and frequency domain filtering techniques
CO3	Apply image sampling and quantization techniques.
CO4	Implement image enhancement and restoration methods
CO5	Demonstrate knowledge of image segmentation algorithms.
CO6	Design multimedia applications of digital image processing.

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Digital Image Processing** **Basics of image processing:** Define Digital Image Processing, Examples of Fields that Use Digital Image Processing, Elements of Visual Perception. Image Formation, Image types, **Image Sensing and Acquisition:** Image Acquisition Using a Single Sensor, Image Acquisition Using Sensor Strips, Image Acquisition Using Sensor Arrays. **Image Sampling and Quantization:** Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-Level Resolution, Aliasing and Moiré Patterns, Zooming and Shrinking Digital Images and Basic Relationships Between Pixels.	**12**
II	**Image Enhancement**, **Filtering and restoration** Introduction to theories, algorithms, and practical solutions of digital image perception, acquisition, color representation, quantization, transform, enhancement, filtering, multi-spectral processing, restoration, analysis, feature extraction, segmentation, morphological transform, and compression, Algorithm design, mathematical tools, and practical implementations of various digital image applications.	**16**

III	**Image Analysis and Computer Vision** Spatial feature extraction, Transform Features, Edge Detection, Boundary Extraction, Boundary Representation, Region Representation, Moment Representation, structure, shape features, Textures, Scene Matching and Detection, Image Segmentation, Classification Techniques, Image understanding.	**16**
IV	**Overview of Image Data Compression** Pixel Coding, predictive Techniques, RLE,LZW compression, comparison of various image file formats, TGA, GIF, TIFF, BMP, JPEG, CDR.	**16**

Reference Books:

1. Rafel.C.Gonzalez, Richard .E.Woods, “Digital Image Processing”, Pearson Third Edition,2008.
2. Rafel.C.Gonzalez, Richard .E.Woods and Steven L. Eddins “Digital Image Processing usind MATLAB”, Pearson 2004.
3. Anil.K. Jain, “Fundamentals of Digital Image Processing”, Pearson, 2002.
4. Keenneth R Castleman, "Digital Image Processing", Pearson Education, 1995.

S.Y. M. Sc. Semester III		
ELS-610	**Research Project- I**	**Credits:** 4

Introduction:

The NEP 2020 has emphasized on the inclusion of research and development in Higher Education Institutions. As colleges are an integral part of knowledge importation and creation NEP 2020 has introduced the research component to quite a substantial degree at postgraduate level. The multidisciplinary, transdisciplinary and translational research culture is expected to be introduced at postgraduate level. Such research projects undertaken will obviously enhance the research productivity, collaboration at national and international level in various industries, government as well as community based organizations and agencies.

Course Objective	
1	To enable the students to undertake research projects that are relevant and important.
2	To apply pre-learnt concepts to design research problem with help of literature survey.
3	To enable students to do sufficient groundwork in terms of preparing the outline of research plan which includes grants, infrastructural requirements and procurement of resources.
4	To allow students the opportunity to develop a thorough research proposal. UGC guidelines to be followed for writing the research proposal.
5	To encourage research culture which includes exploring collaborative project ideas.

Outcome	
1	Students will do the groundwork for research in terms of identifying a relevant research topic (relevance will be decided based on the subject). Identifying the queries and literature review.
2	Define well formulated specific objectives that help develop the overall research methodology,
3	By the end of the semester the student is expected to compile and communicate the Research Proposal with proper format and if possible have procured funding for the same.

Evaluation

1. The total credits for the research project are 4. Hence internal evaluation will be of 40 marks and external evaluation will be of 60 marks.
2. Students will be allowed to work individually or in groups (maximum number of students in each group should not exceed 4).
3. The pattern of evaluation will be as follows:

	Examiner for Internal exam	Examiner for External exam	Nature of evaluation (Internal)	Nature of evaluation (External)
SEM-III	Internal guide	External subject expert	Periodic assessment of ideation and proposal development	Student(s) present research proposal

Parameters for assessment

(Based on overall performance and oral presentation/ viva voce for the dissertation)

SR. NO.	POINTS / Evaluation Parameters
1	Selection Project Idea/Topic and Originality of the research problem identified
2	Significance of the Work and Literature Review
3	Review A statement of Aims and Objectives
4	Plan of Research Project
5	Thoroughness of the proposal in terms of methodology, apparatus/equipment required and timeline (PERT chart).
6	Defines a pilot project or study as an experimental, exploratory, test, preliminary, trial or try out investigation for the defined Research Project proposal.
7	Regularity of work carried
8.	Bibliography
9.	Demonstration
`10	Submission of pilot study project report.

S.Y. M. Sc. Semester III		
ELS-620	**Electronics Practical-V**	**Credits:** 2 **Hours:** 60
Course Outcome (COs): **On completion of the course, the students will be able to**		
CO1	Recall and design communication electronic circuits using discrete components and ICs.	
CO2	Understand various communications and networking topology.	
CO3	Create and apply the concept of inspection, quality control and its importance to industries.	
CO4	Identify, compare and study various wired, wireless, networking hardware components/ devices.	
CO5	Design and validation of advanced control strategies for the given process.	
CO6	Develop ability to design, build and test application circuits.	

Experiment List for Electronics Practical-V

ELS -601: Data Communication and Networking

Sr. No	Experiment Title
1.	Delta modulation and demodulation
2.	Design PCM encoder and decoder system
3.	Design of ASK transmitter and receiver
4.	Quadrature-Amplitude modulation (QAM)
5.	Generation and reception of QPSK
6.	Design of FSK transmitter and receiver
7.	Time division Multiplexing/FDM
8.	Phase Shift Keying (BPSK/QPSK)
9.	BPSK Modulation and Demodulation
10.	Introduction to Cisco Packet Tracer
11.	Different physical equipment and internetworking devices in computer networks used for networking.
12.	Creation of the Mesh topology using Scilab/octave.
13.	Creation of the Star topology using Scilab/octave.
14.	To study and configure HUB/Switch using Cisco Packet Tracer

15.	Study of basic network commands, Using Networking commands: ping, hostname, traceroute, netstat, ipconfig, who, nslookup etc… and Network configuration commands.

General Electronics Experiment List:

Sr. No	Experiment Title
1.	Signal conditioning circuits for analog controller
2.	Design and implement ON-OFF Controller
3.	Design and implement P / PI / PID controller
4.	Displacement measurement using LVDT, signal conditioning and DPM
5.	Temperature measurement using PT100, signal conditioning and DPM
6.	Temperature measurement using thermocouple with cold junction compensation
7.	Design and calibrate light intensity meter using photodiode or LDR and the necessary signal conditioning and display

Note: Any other equivalent experiment

S.Y. M. Sc. Semester III		
ELS-621	**Electronics Practical-VI**	**Credits:** 2 **Hours:** 60
Course Outcome (Cos): **On completion of the course, the students will be able to**		
CO1	Identify the different types of communication media and networking devices.	
CO2	Demonstrate and summarize different network topologies with respect to servers and clients.	
CO3	Demonstrate the advanced peripherals to ARM /CORTEX based microcontrollers.	
CO4	Illustrate the TCP/IP and OSI reference model and identify their differences in implementation within and across enterprise.	
CO5	Test and validate various automation systems for industrial applications.	
CO6	Design Real time embedded system using ARM/CORTEX4	

Electronics Practical-VI:

ELS -602: Embedded Processors: LPC2148 / STM32F4xx Based Experiments

Sr. No	Experiment Title
1.	Basic Assembly level Programmes
2.	GPIO Programming
3.	Interfacing Alphanumeric LCD / Interfacing key board
4.	Programming ADC
5.	Programming DAC
6.	Interfacing external interrupt.
7.	Programming RTC / EEPROM / I2C
8.	Programming UART
9.	Interfacing SD card
10.	Interfacing EEPROM to LPC2148 using I2C protocol
11	Interfacing Seven Segment LED
12	Transmit a character from keyboard using on chip UART
13	To control speed and direction of DC Motor using PWM Block for STM32F4xx
14	Interfacing Ultrasonic Sensor HC-SR04 with STM32F4xx.
15	Interfacing LDR and MQ3 sensor with STM32F4xx
16	Note: Any other equivalent practical

ELS604: VLSI System Design

Sr. No	Experiment Title
1.	Output and Transfer Characteristics of n-channel MOSFET
2.	Simulation Design of CMOS Inverter Transfer Characteristics
3.	Investigation of VTC Characteristics
4.	Transient Response of CMOS Inverter and Ratioed Circuit (NMOS Load)
5.	Transient Response of CMOS Inverter and Ratioed Circuit (PMOS Load)
6.	Functionality of a 2-input NAND gate
7.	Functionality of a 2-input NOR gate

ELS-605 Elective: Image Processing using Octave/MATLAB/C programming

Sr. No	Experiment Title
1.	Histogram Equalization for Contrast Enhancement.
2.	Spatial Filtering for Noise Reduction and Edge Enhancement
3.	Frequency Domain Filtering using Fourier Transform
4.	Image Restoration using Wiener and Inverse Filtering
5.	Image Segmentation using Threshold and Watershed Algorithm
6.	Feature Extraction and Object Recognition
7.	JPEG Image Compression with Varying Quality Levels
8.	Interactive Multimedia Application using MATLAB GUI
9.	Image Recognition using Pre-trained Deep Learning Models in MATLAB
10.	Project-Based Experiment

Note: Any other equivalent experiment

S.Y. M. Sc. Semester IV		
ELS-651	**Industrial Process Control**	**Credits:** 4 **Hours:** 60
Course Outcome (COs): **On completion of the course, the students will be able to**		
CO1	Identify the different control systems in the real time applications.	
CO2	Explain the basic elements of the process control system, PLC and SCADA.	
CO3	Classify the operational modes of various process Controllers.	
CO4	Analyze appropriate sensors and actuators for a given automation system.	
CO5	Evaluate different control parameters for the optimal performance of the control system.	
CO6	Develop the PLC program for discrete state process control.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Process Control** Introduction to Control System, Open loop and closed loop control system, Feedback and Feed forward system, Process-Control Block Diagram, Introduction of Industry 5.0, Industrial IoT **Controller Principles:** Process characteristics, Control system parameters, Discontinuous modes, Continuous controller Modes (Proportional, Integral, and Derivative Control mode), Composite Control Modes (Proportional-Integral (PI), Proportional-Derivative (PD), PID controllers)	**12**
II	**Analog Controllers** General features, Electronic Controllers, Pneumatic Controllers Final control: Final control operation, Signal conversions, Power Electronics, Actuators, Control Elements **Control loop Characteristics:** Control system Configuration, Multivariable Control System, Control System Quality and Stability, Process-loop tuning, Stability criterion: Routh-Hurwitz and Nyquist plot	**16**

III	**Programmable logic controller** Basic control relay logic, What is PLC, concept of PLC, Building blocks of PLC, Functions of various blocks (Power supply, CPU, I/Os List), and limitations of relays, Advantages of PLCs over electromagnetic relay, PLC manufacturer etc. Communication bus Various ranges available in PLC's),Types of Inputs and outputs / Source Sink Concepts, Wiring of the I/O devices, Architectural Evolution of PLC, Introduction to the field devices, Wiring of the I/O devices, Concept of flags and Scan cycle execution	**16**
IV	**PLC Programming** Different programming languages**,** Ladder and functional block programming, Timer, Counter, Developing Fundamental PLC, Wiring Diagrams and Ladder Logic Programs Working of PLC: - Basic operation and principles of PLC - Scan Cycle,- Memory structures, I/O structure PLC Wiring Diagrams and Ladder Logic Programs for interfacing sensors and actuators with PLC, Introduction to SCADA, SCADA system application(Oil GAS / factory /Metro/ Solar Power Plant /Steel Plant),HMI	**16**

Reference Books:

1. Process Control Instrumentation Technology, Curtis D. Johnson, Eighth Edition, (2008)
2. Control System-I, U.A. Bakshi, V.U. Bakshi, Technical Publications, 3rd Edition, (2012)
3. Programmable Logic Controllers, W. Bolton,4th Edition, 2006
4. Practical SCADA for Industry David Bailey BEng, Bailey and Associates, Perth, Australia (2003)
5. Programmable Logic Controllers, by Frank D. Petruzella, Fourth Edition (2017**)**

S.Y. M. Sc. Semester IV		
ELS-652	**Internet of Things**	**Credits:** 4 **Hours:** 60

Course Outcome (COs): **On completion of the course, the students will be able to**	
CO1	Remember the basic concept and requirement of Internet of Things
CO2	Understand the fundamentals of IoT architecture, IoT protocols, security mechanisms and implementation of secure infrastructure for IoT
CO3	Apply the knowledge of embedded system for design of IoT system using suitable microcontroller
CO4	Implement the IOT applications using Python Programming
CO5	Evaluate the knowledge of WSN for implementation IoT application
CO6	Design different real time applications of IoT

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Internet of Things:** Definition and characteristics of IoT, Internet of Things: Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things in IoT, IoT Communication APIs, IoT enabling technologies, Wireless Sensor Networks, IoT levels and deployment templates, IoT Issues and Challenges, Applications	**12**
II	**IoT Physical Devices and Endpoints** Basic building blocks of an IoT device, horizontal and verticals of IoT applications, four pillars of IoT, M2M: The internet of devices, RFID: The internet of objects, WSN: The internet of transducer, SCADA: Choosing platform for IoT development, Choosing IoT hardware processor (Arduino, Raspberry Pi etc.), IoT and M2M, SDN and NFV for IoT	**16**

III	**IoT Protocols, Security and Web/ Cloud of Things** IoT protocols, Protocol Standardization for IoT, Issues with IoT Standardization, Unified Data Standards, Protocols- IEEE 802.15.4, BACNet Protocol, Modbus IoT Security: Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modeling, Key elements of IoT Security Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Cloud Standards – Cloud Providers and Systems, Mobile Cloud Computing, The Cloud of Things Architecture, Data Handling and Analytics Big Data Analytics, Fog Computing	**16**
IV	**IoT Systems – Logical Design using Python Programming** Introduction to Python, Installing Python, Python Data Types and data structures, control flow, Functions, Modules, Packages, Object oriented programming, Classes, File handling, Date/Time operations, Python Packages of interest for IoT, GUI programming for IoT, Python programming for interfacing of different processors. Design of real time IoT applications using different microcontroller and Python Programming Case Study: Agriculture, Healthcare, Activity Monitoring, Automation..	**16**

Reference Books:

1. Reema Thareja, "Python Programming Using Problem Solving Approach", Oxford University Press, ISBN 13: 978-0-19-948017-6
2. R. Nageswara Rao, "Core Python Programming", Dreamtech Press; Second edition ISBN-10: 938605230X, ISBN-13: 978-9386052308 ASIN: B07BFSR3LL
3. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515
4. Raj Kamla, Internet of Things, Architecture and design Principles, McGraw Hill Education (India) Private Limited.
5. Honbo Zhou, ―The Internet of Things in the Cloud: A Middleware Perspective‖, CRC Press, 2012. ISBN : 9781439892992
6. Lyla B. Das, ―Embedded Systems: An Integrated Approach‖ Pearson
7. Olivier Hersent, Omar Elloumi and David Boswarthick, ―The Internet of Things: Applications to the Smart Grid and Building Automation, Wiley, 2012

S.Y. M. Sc. Semester IV		
ELS-653	**Electric Vehicles and Hybrid Electrical Vehicles (Elective –I Theory)**	**Credits:** 4 **Hours:** 60

Course Outcome (COs):
On completion of the course, the students will be able to

CO1	Understand history & importance of Electrical Vehicles
CO2	Study of feature and selection techniques for EVs and HEVs
CO3	Understand operation of various types of converters, explain the construction and working principle of various motors used in electric vehicles
CO4	Describe the different types and working principle of hybrid vehicles.
CO5	Explain fundamentals of electric and hybrid vehicles.
CO6	Demonstrate about working principle of electronics and sensor less control in electric vehicles

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Electric Vehicle (EV) & Hybrid Vehicle (HV)** **Introduction to Hybrid Electric Vehicles**: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Conventional Vehicles**: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	**12**
II	**Hybrid Electric Drive-trains:** Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. **Electric Drive-trains**: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. **Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives	**16**
III	**Energy Storage:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell	**16**

	based energy storage and its analysis, Hybridization of different energy storage devices. **Sizing the drive system:** Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.	
IV	**Communications, supporting subsystems:** In vehicle networks: Controller Area Network (CAN) and Local Interconnect Network (LIN) **Energy Management Strategies**: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies	**16**

Text / Reference Books:

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003.
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication ,2011.
4. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009.
5. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
6. Lino Guzzella and Antonio Sciarretta, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2nd Edition, 2009
7. James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley, 1st Edition, 2003
8. Lino Guzella, Antonio Sciarretta, Vehicle Propulsion Systems: Introduction to Modeling and Optimization, Springer, 2nd Edition, 2007.

Web Resources:

1. Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000
http://nptel.ac.in/courses/108103009/

S.Y. M. Sc. Semester IV		
ELS-654	**Artificial Intelligence and Machine Learning (Elective –I Theory)**	**Credits:** 4 **Hours:** 60

Course Outcome (COs):

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

CO1	DEMONSTRATE fundamentals of artificial intelligence and machine learning.
CO2	APPLY feature extraction and selection techniques.
CO3	APPLY machine learning algorithms for classification and regression problems.
CO4	DEVISE AND DEVELOP a machine learning model using various steps.
CO5	EXPLAIN concepts of reinforced and deep learning.
CO6	SIMULATE machine learning model in Electronics problems.

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to AI & ML** History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation. Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning.	**12**
II	**Feature Extraction and Selection** **Feature extraction**: Statistical features, Principal Component Analysis. Feature selection: Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering. **Classification & Regression** **Classification**: Decision tree, Random Forest, Naive Bayes, Support vector machine. Regression: Logistic Regression, Support Vector Regression. Regression trees: Decision tree, random forest, K-Means, K-Nearest Neighbour (KNN). Applications of classification and regression algorithms in Electronics.	**16**

III	**Development of ML Model** **Problem identification**: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions. **Reinforced and Deep Learning** Characteristics of reinforced learning; Algorithms: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; Models: Markov Decision Process, Q Learning. Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network. Application of Reinforced and Deep Learning in Electronics.	**16**
IV	**Applications** Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms.	**16**

Reference Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), “Artificial Intelligence: A Modern Approach,” Third edition, Pearson, 2003.
5. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018. 2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
6. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
7. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
8. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Web References:

1. http://nptel.ac.in/courses/111101003/
2. https://nptel.ac.in/courses/106/106/106106202/
3. https://nptel.ac.in/courses/112/103/112103280/

https://www.analyticsvidhya.com/

S.Y. M. Sc. Semester IV		
ELS-661	**Research Project-II**	**Credits:** 6

Introduction:

The research project proposal needs to be implemented by following the given timeline Under the NEP, students are expected to get industry ready by the time they pass out of their Masters' degree course. There is also an emphasis on research so that every student is expected to carry out independent research project as a part of their Post Graduate program. The emphasis is on research that is socially applicable, and carried out with scientific rigor. One benchmark of good quality research is publication of the project either in International or National level scientific journals or the presentation of students' research work at International, National or State level conferences. With this broad objective, the following has been proposed for student research projects at Masters level.

Course Objective	
1	To facilitate substantial data collection for the proposed research work
2	To carry out research following ethical aspects of research activities.
3	To compile and communicate the findings/conclusions / results obtained in the science community through various means of communication.
4	To enable students to put together a research paper that can be published or presented at conferences.

Outcome	
1.	Carry out a substantial research-based project
2.	Capacity development to analyse data and process research findings
3.	Use research findings to advance education theory and practice.
4.	Focus on quality review of the research papers and may be published in peer reviewed journals or may be presented in conferences / seminars. The research project outcome can be considered for evaluation based on following criteria.
5.	Research Publication in Peer reviewed, Scopus / UGC -CARE indexed journal.
6.	Poster/ Oral Presentation in seminars/ conferences outside the institute
7.	Poster/ Oral Presentation in seminars/ conferences arranged by the institution.
8.	The dissertation will be done as per the guidelines of UGC

Evaluation

I. The total credits for the research project are 6. Hence internal evaluation will be of 60 marks and external evaluation will be of 90 marks.

II. Students will be allowed to work individually or in groups (maximum number of students in each group should not exceed 4).

III. The pattern of evaluation will be as follows:

	Examiner for Internal exam	**Examiner for External exam**	**Nature of evaluation (Internal)**	**Nature of evaluation (External)**
SEM-IV	Internal guide	External subject expert	Periodic assessment of data collection, analysis and report writing	Student(s) present research report. 30 marks to be allotted for publication/presentation at conference

Parameters for assessment

(Based on overall performance and oral presentation/ viva voce for the dissertation)

SR. NO.	**POINTS / Evaluation Parameters**
1	Continuous Assessment of day-to-day work
2	Record keeping/ maintenance of journal
3	Ability design work protocol and troubleshooting
4	Proficiency of Presentation skills and use of audio-visual aids
5	Effective data representation (eg. Graphs, chats etc.)
6	Research Potential of the work, result and interpretation
7	Outline of the study and possible future plans
8	The dissertation report preparation (Scientific writing) and its contents
9	Abilities of satisfactory responses to the queries from the audience
10	Publication potential of the work (25% overall weightage to be given)

S.Y. M. Sc. Semester IV		
ELS -670	**Electronics Practical-VII**	**Credits:** 2 **Hours:** 60
Course Outcome (COs): **On completion of the course, the students will be able to**		
CO1	Carry out IoT based case studies like home automation, cities, environment, Agriculture etc.	
CO2	Understand of IoT concepts such as sensors, actuators, communication protocols, and data analysis.	
CO3	Students Learn and Develop Problem-Solving Skills. The IoT case study provides practical, hands-on experience with IoT hardware and software components.	
CO4	Students enhance their technical proficiency in areas such as programming, electronics, and networking. IoT case studies involve teamwork, allowing students to collaborate with peers, share ideas, and work towards a common goal.	
CO5	By the end of the semester the student is expected to demonstration, documentation and evaluation report.	
CO6	Evaluate the success of the case study based on the defined objectives and gather feedback for future improvements.	

Guidelines:

Implement and demonstrate any IoT case studies typically involves several steps:

1. **Identify the Two Case Study Related to IoT**:

   Choose a specific IoT application or scenario that you want to explore. This could be

   - Smart home automation,
   - Industrial monitoring,
   - Environmental sensing,
   - Agriculture,
   - Healthcare,
   - Industrial IoT
   - Electric vehicle
   - Productivity applications
   - Real time systems (RTOS)
   - AI/ML
   - Any equivalent area/platform

2. **Define Objectives**:

   Clearly define the objectives of your case study. What do you aim to achieve or demonstrate through this project?

For example, it could be improving efficiency, reducing costs, enhancing safety, etc.

3. **Select Hardware**:

   Choose the necessary hardware components based on your case study requirements.

   This may include sensors, actuators, microcontrollers, communication modules (Wi-Fi, Bluetooth, LoRa, etc.), and any other relevant hardware.

4. **Design Architecture**:

   Design the architecture of your IoT system. Determine how the hardware components will interact with each other and with the cloud or edge computing infrastructure.

   Consider issues like data collection, processing, storage, and communication protocols.

5. **Develop Software**:

   Develop the software components needed for your IoT system.

   This includes firmware for the devices, backend services for data processing and storage, and user interfaces for interaction (web apps, mobile apps, dashboards, etc.).

6. **Integration and Testing**:

   Integrate the hardware and software components together and test the entire system thoroughly. Ensure that all components are working as expected and that data is being collected, processed, and transmitted accurately.

7. **Data Analysis and Visualization**:

   Analyze the data collected by your IoT system to derive insights and draw conclusions. Use data visualization techniques to present your findings in a clear and understandable manner.

8. **Demo Preparation**:

   Prepare a demo of your IoT case study to showcase its functionality and effectiveness. This may involve setting up a demo environment, and presentation.

   Demo Execution: Conduct the demo of your IoT case study, either in a controlled environment or to a specific audience. Demonstrate how the system works, highlight its key features and benefits, and be prepared to answer any questions or address any concerns.

9. **Documentation and Evaluation**:

   Document your IoT case study, including details of the implementation, challenges faced, lessons learned, and outcomes achieved. Evaluate the success of the case study based on the defined objectives and gather feedback for future improvements.

   By following these steps, you can effectively implement and demonstrate IoT/ Industrial Process Control /EVs and HEVs and AR-VR case studies to showcase the potential of various technologies in various real-world applications.

Practical List:

ELS -651: Industrial Process Control

Sr. No	Experiment Title
1.	Signal conditioning circuits for analog controller
2.	Design and implement ON-OFF Controller
3.	Design and implement P / PI / PID controller
4.	To study the position / velocity control of dc servo motor
5.	Study of stability of process control system and time domain performance of control system
6.	Study of actuators
7.	PLC Programming: Relay programming (all logic gates, Boolean equation like multiplexer, demultiplexer, encoder, decoder, latch etc.)
8.	PLC Program to Control Traffic Lights
9.	PLC Program to Count and Pack Parts from Conveyor
10.	Water level controller using PLC
11	Conveyor belt control/Temperature controller/Alarm monitor program/Car parking System/Vending machine/ AC motor drive programming Elevator
	Note: Any other equivalent practical

ELS-652: Internet of Things

Experiments using Arduino/Raspberry Pi or equivalent board:

Sr. No	Experiment Title
1.	Interface LED/Buzzer and write a program to turn ON/OFF LED/Buzzer.
2.	Interface Push button/Digital Sensor (IR/LDR)
3.	Interface DHT 11 with Arduino/Raspberry Pi and write a program to display Temperature and Humidity on display device
4.	Interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to a smartphone using Bluetooth.
5.	Interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when “1” or”0” is received from a smartphone using Bluetooth.

6.	Upload Temperature/ Humidity data on Thing speak etc. cloud.Retrieve temperature /humidity data from Thing speak or any cloud.
7.	Installation of MySQL on Raspberry Pi and perform basic SQL queries.
8.	Program Arduino/Raspberry Pi to publish temperature data to MQTT broker. Program Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
9.	Interface motor using relay with Arduino/Raspberry Pi and write a program to turn on motor when push button is pressed or at a sensor detection.
10.	IoT based Web Controlled Home Automation using Protocols.
11	Note: Any other equivalent practical

ELS -653: EVs and HEVs

Sr. No	Experiment Title
1.	Study and analysis of different topologies used in electrical and hybrid vehicles
2.	Simulation and analysis of Induction motor characteristics used for electric vehicle
3.	Simulation and analysis of BLDC motor characteristics used for electric motor vehicle
4.	Simulation and analysis of Switch Reluctance motor characteristics used for electric motor vehicle
5.	Simulation and analysis of IPMSM motor characteristics used for electric motor vehicle
6.	Analysis of selection of drives used for electric and hybrid vehicle
7.	Simulation and analysis of speed control characteristics of Induction motor used for electric vehicle
8.	Simulation and analysis of speed control characteristics of BLDC motor used for electric motor vehicle
9.	Simulation and analysis of torque control characteristics of IPMSM motor characteristics used for electric motor vehicle
10.	Analysis of Vector control methods for Induction motor used for electric vehicle
11	Simulation and analysis of field control of IPMSM motor used for electric vehicle

ELS654: Artificial Intelligence and Machine Learning

Sr. No	Experiment Title
1.	To study supervised/unsupervised/Reinforcement learning approach.
2.	To acquire, visualize and analyze the data set (from time-domain/ frequency-domain/ etc.)
3.	To extract features from a given data set and establish training data.
4.	To classify features/To develop classification model and evaluate its performance (any one classifier).
5.	To develop a regression model and evaluate its performance (any one algorithm).
6.	Markov process for modelling manufacturing processes. OR Reinforced Learning for optimizing engineering designs / Robot Guidance and Navigation.
7.	GA for optimization of multi-dimensional function / path planning in robotics. OR NN for parameter and model identification / tuning of Control Algorithms.

Note: Any other equivalent experiment