Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE

Syllabus

for

M. Sc.

(Electronic Science)

(Semester-III and Semester-IV)

From Academic Year

2024-25

Program Structure of M.Sc. (Electronic Science) Part-II

Semester	Paper Code	Paper Title	Subject	Credits
III	ELS -601	Data Communication and Networking	Theory	4
	ELS -602	Embedded Processors	Theory	4
	ELS-603	Artificial Intelligence and Machine Learning	Elective –I Theory	2
	ELS -604 OR ELS-605 OR ELS-606	VLSI System Design	Elective –II Theory	2
		Image Processing	Elective –III Theory	
		Digital Signal Processing	Elective –IV Theory	
	ELS -610	Research Project-1	RP-1	4
	ELS -620	Electronics Practical-V	Practical	2
	ELS -621	Electronics Practical-VI	Practical	2
		Total Semester Credits		20
IV	ELS -651	Industrial Process Control	Theory	4
	ELS -652	Internet of Things	Theory	4
	ELS -653	Electric and Hybrid Electric Vehicles	Elective –I Theory	2
	ELS -654 OR ELS -655 OR ELS-656	Real Time Operating System	Elective –II Theory	2
		Augmented Reality and Virtual Reality	Elective –III Theory	
		Mechatronics	Elective –IV Theory	
	ELS -661	Research Project-2	RP-2	6
	ELS -670	Electronics Practical-VII	Practical	2
		Total Semester Credits		20
		Total PG-II Credits		40

S.Y. M.Sc. Semester III		
ELS-601	**Data Communication and Networking**	**Credits:** 4 **Allocated Hours:** 60Hrs
Allocated marks	**CE- 40 and ESE-60**	**Total = 100 Marks**

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	Contents
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 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.
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

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.

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 **Allocated Hours:** 60Hrs
Allocated marks	**CE- 40 and ESE-60**	**Total = 100 Marks**
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 and standard buses. Will also be able to develop embedded applications using different case studies.	

Unit	Contents
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
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, 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.
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.

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 **Elective –I**	**Artificial Intelligence and Machine Learning**	**Credits:** 2 **Allocated Hours:** 30Hrs
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**

Course Outcome (COs): On completion of the course, the students will be able to	
CO1	Fundamentals of artificial intelligence and machine learning
CO2	Understand machine learning algorithms for classification and regression problems.
CO3	Explain concepts of reinforced and deep learning.
CO4	Apply feature extraction and selection techniques.
CO5	Simulate machine learning model in Electronics problems
CO6	Devise and develop a machine learning model using various steps

Unit	Contents
I	**Introduction to AI and ML** Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning, Statistical Analysis: Relationship between attributes: Covariance, Correlation Coefficient, Chi Square. Intelligent Agent: Concept of Rationality, nature of environment, structure of agents.
II	**Learning from examples** Overview of different forms of learning, Supervised learning, Unsupervised learning, Learning Decision Trees, regression and classification with linear model, SVM, Ensemble learning, Reinforcement learning. Artificial neural network
III	**Introduction to Expert Systems** Inference - Forward chaining - Backward chaining - Languages and tools - Explanation facilities - Knowledge acquisition. **Applications**: Natural Language Processing: General framework for text processing. **Case Study**: Sentiment Analysis.Computer Vision: General framework for CV application. Case Study: Object Recognition

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.
6. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
7. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
8. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
9. 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/
4. https://www.analyticsvidhya.com/

S.Y. M.Sc. Semester III		
ELS-604 **Elective-II**	**VLSI System Design**	**Credits:** 2 **Allocated Hours:** 30Hrs
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**

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	Identify the sources of power dissipation in a CMOS circuit
CO4	Design combinational and sequential circuits using CMOS gates
CO5	Analyze SRAM cell and memory arrays
CO6	Discuss applications of VLSI

Unit	Contents
I	**Introduction to VLSI Design** Different types of VLSI design styles: Full custom, standard cell based, gate array based, programmable logic, field programmable gate arrays etc. VLSI Design flow. **CMOS logic**: PMOS, NMOS and CMOS, Electrical characteristics, operation of MOS transistors as a switch and an amplifier, MOS inverter, stick diagram, design rules and layout, delay analysis, different type of MOS circuits: Dynamic logic, BiCMOS, pass transistors etc.
II	**MOS Transistors** CMOS Logic, CMOS Fabrication and Layout, Design Partitioning, Fabrication, Packaging, and Testing, MOS transistor Theory, Long Channel I-V Characteristics, C-V Characteristics, Non-Ideal I-V Effects, DC Transfer Characteristics. **The CMOS Inverter**: The Static CMOS Inverter, An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter. The Static Behaviour, Performance of CMOS Inverter, the Dynamic Behaviour. MOS process, Combinational logic cells, Sequential logic cells, Datapath logic cells, I/O cells. CMOS Processing Technology, CMOS Technologies,

	Layout Design Rules, CMOS Process Enhancements, Technology-Related CAD Issues, Manufacturing Issues. **Circuit Simulation- A SPICE Tutorial**: Device Models, Device Characterization, Circuit Characterization, Interconnect Simulation. Combinational Circuit Design, Circuit Families, Silicon-On-Insulator Circuit Design, Sub Threshold Circuit Design.
III	**Sequential Circuit Design**, Circuit Design of Latches and Flip-Flops, A logic synthesis example. **Floor-planning and Placement**: I/O and power planning, clock planning. Routing global and detailed. **Example design technique**: mapping of architecture to silicon Array Subsystems, SRAM, DRAM, Read-Only Memory, Serial Access Memories, Content Addressable Memory, Programmable Logic Arrays

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.
9. D. D. Gajaski, N. D. Dutt, A. C.-H. Wu and S. Y.-L. Lin, High-Level Synthesis: Introduction to Chip and System Design, Kluwer Academic Publishers.

S.Y. M.Sc. Semester III		
ELS-605 **Elective-III**	**Image Processing**	**Credits:** 2 **Allocated Hours:** 30 Hrs
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**
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	Contents
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.
II	**Introduction to Digital Image fundamentals** 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.

Text / 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-606 **Elective-IV**	**Digital Signal Processing**	**Credits:** 2 **Allocated Hours:** 30 Hrs
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**
Course Outcome (COs): On completion of the course, the students will be able to		
CO1	Understand Processor architecture, DSP based hardware design and application.	
CO2	Interpret, represent and process discrete/digital signals and systems.	
CO3	Aware of the mathematical background required for DSP.	
CO4	Design of digital filters and implementation on digital Signal Processor.	
CO5	Analyze DSP systems like FIR and IIR Filter etc.	
CO6	Implementation of DT filters like FIR and IIR Filter etc	

Unit	Contents
I	**DSP Preliminaries** Digital signal processing and its benefits, application areas, Key DSP, operations (convolution, correlation etc), Digital signal processors, real world applications of DSP, Audio applications of DSP, Telecommunication and biomedical applications of DSP, Real time DSP systems, convolution,types of convolution
II	**Digital Filter Design** Framework of digital filter design: introduction, types – infinite impulse response (IIR), finite impulse response (FIR) **FIR filter:** features, filter design steps, design, filter specifications, coefficient calculation methods, window method, optimal method,frequency sampling method, realization structure for FIR filter, finite word length effects, and implementation of FIR filters **IIR Filter:** basic features, design steps, coefficient calculation, poles-zeros placement, impulse invariant method, bilinear transform, Matched z-transform, Nyquist effect, realization structure for IIR filter, finite word length effects, implementation of IIR filters

Reference Books:

1. Digital Signal Processing: A Practical Approach, Emmanuel Ifeachorand Barrie Jervis, PHI.
2. Digital Signal Processing: S. Salivahan, A. Valuraj, C.Gnanapriya, TMH, , 2006.
3. Digital Signal Processing: A Hands on Approach: Charles Schuller, Mahesh Chugani, Tata
4. McGraw Hill Pub. Co. Ltd. Edn. 2006.
5. Digital Signal Processing: Principles, Algorithms and Applications: John G. Proakis and Dimitris G Monolkis, Person, 2005.
6. Operating Systems Concept, Galvin, John Willey and Sons.
7. Digital Signal Processing and Applications with the C6713 and C6416 DSK, RulphChassaing, a John Wiley & Sons, Inc.
8. The Scientist and Engineer's Guide to Digital Signal Processing, Steven W. Smith, Second Edition California Technical Publishing.

S.Y. M.Sc. Semester III		
ELS-610	**Research Project-1**	**Credits:** 4
Allocated marks	**CE- 40 and ESE-60**	**Total = 100 Marks**

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

I. 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.
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-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 **Allocated Hours:** 4Hrs /week
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**
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.	

S.Y. M.Sc. Semester III		
ELS-621	**Electronics Practical-VI**	**Credits:** 2 **Allocated Hours:** 4Hrs /week
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**
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	

Experiment List for Electronics Practical-V and Electronics Practical-VI:

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.

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

ELS603: Artificial Intelligence

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.

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

ELS-606 Elective: Digital Signal Processing /DSP Board

Sr. No.	Experiment Title
1.	Generation of signals Impulse, Step, Exponential and Ramp functions
2.	Design of FIR filter
3.	Design of IIR filter
4.	Linear and circular convolution
5.	Concept of Aliasing
6.	DFT computations
7.	FFT Computations
8.	Convolution of two discrete signals
9.	Waveform generation
10.	FIR Filter design and IIR filter design on DSP board

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

SEM-IV

S.Y. M.Sc. Semester III		
ELS-651	**Industrial Process Control**	**Credits:** 4 **Allocated Hours:** 60 Hrs
Allocated marks	**CE- 40 and ESE-60**	**Total = 100 Marks**
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	Contents
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)
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
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
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

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 III		
ELS-652	**Internet of Things**	**Credits:** 4 **Allocated Hours:** 60 Hrs
Allocated marks	**CE- 40 and ESE-60**	**Total = 100 Marks**
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.	Contents
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
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

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
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..
	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. Dieter Uckelmann, Mark Harrison, Florian Michahelles, ―Architecting the Internet of Things‖, Springer, 2011. ISBN: 978-3-642-19156-5 7. Lyla B. Das, ―Embedded Systems: An Integrated Approach‖ Pearson 8. 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 III		
ELS-653 **Elective –I**	**Electric and Hybrid Electric Vehicles**	**Credits:** 2 **Allocated Hours:** 30 Hrs
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**
Course Outcome (COs): On completion of the course, the students will be able to		
CO1	Explain the fundamentals of electric and hybrid vehicles.	
CO2	Understand history and importance of Electrical Vehicles	
CO3	Operation of various types of converters.	
CO4	Describe the different types and working principle of hybrid vehicles.	
CO5	Case Study of feature , selection techniques for EVs and HEVs.	
CO6	Demonstrate the working principle of electronics and sensor less control in electric vehicles	

Unit	Contents
I	**Introduction to Electric Vehicle (EV) and Hybrid Electric Vehicle (HEV)** A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train and analysis of series drive train., vehicle motion and the dynamic equations for the vehicle, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment. **Power Management and Energy Sources of EV and HEV Introduction** Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery-based energy storage and simplified models of battery, Battery Management Systems (BMS), fuel cells, Super capacitor-based energy storage, flywheels and their modelling for energy storage in HV/BEV, hybridization of various energy storage devices, Selection of the energy storage technology.
II	**Power Electronics in EV and HEV**

	Introduction, various power electronics converter topologies and its comparisons, Control of convertor operations in EV and HV, battery chargers used in EV and HV. **DC and AC Machines and Drives in EV and HV** Various types of motors, selection and size of motors, Induction motor drives and control characteristics, Permanent magnet motor drives and characteristics, Brushed and Brushless DC motor drive and characteristics, switched reluctance motors and characteristics, IPM motor drives and characteristics, mechanical and electrical connections of motors
III	**Electric and Hybrid Electric Vehicles Technologies** Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, preliminary discussion on vehicle to vehicle and vehicle to personal communication systems, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors, policy regulations and standards for EV and HV, BEE standards, Indian and Global scenario, case studies.

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

S.Y. M.Sc. Semester III		
ELS -654 Elective –II	**Real Time Operating System**	**Credits:** 2 **Allocated Hours:** 30
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**
Course Outcome (COs): On completion of the course, the students will be able to		
CO1	Understand the features and structures of practical Operating System implementations	
CO2	Acquire practical knowledge of Real Time Operating Systems used in embedded systems.	
CO3	Understand the use of multitasking techniques in Real Time Systems.	
CO4	Compare different scheduling algorithms and the schedulability criteria.	
CO5	Analyze real time systems with regard to keeping time and resource restrictions.	
CO6	Design real time embedded systems applications using RTOS.	

Unit	Contents
I	**Real time Systems Concepts:** Foreground / background systems, critical section of code, resources, shared resources, task, process and threads, multiprocessing and multitasking, task scheduling. IPC mechanism shared memory, context switches (or task switches), kernels schedulers, preemptive and non-preemptive kernels, reentrant functions, round-robin scheduling, priorities (task, static, dynamic), priority inversions, deadlock, semaphores, inter task communication, message mailboxes, message queues, interrupt, clock tick, real time system, issues in real time computing, structure of a real time system, hard real time system vs. Soft real time system, advantage and disadvantages of real-time kernels

II	**Real time operating system** Kernel structure: critical sections, task control blocks, task level context switch. Task Management: creating a task, task stacks, stack checking, deleting a task, suspending a task, resume a task. Semaphore Management:creating and deleting a semaphore, waiting on a semaphore, creating a Mutex, deleting Mutex, waiting on Mutex. Message Mailbox Management: crating a mailbox, deleting mailbox, waiting for a message at a mailbox porting an operating system like µC/OS II / RTLinux / Free RTOS or any other equivalent on an Embedded Platform

Text / Reference Books:

1. Steve Furber ARM System On Chip Architecture, Pearson.
2. Andrew Sloss, Dominic Symes and Chris Wright, ARM System Developers Guide – Designing and Optimizing System Software, , ELSEVIER.
3. The insider,,s guide to the PHILIPLS ARM7 based Microcontrollers, An Engineer Introduction
4. LPC 214x User manual (UM10139) :- www.nxp.com
5. M. Naghibzadeh, Operating System Concepts and Techniques
6. Galvin, Operating Systems Concept, John Willey and Sons
7. Achyut Godbole, Operating Systems, TMH
8. Jean J. Labrosse , MicroC/OS-II The Real-Time Kernel, Elsevier

S.Y. M.Sc. Semester III		
ELS-655 Elective –III	**Augmented Reality and Virtual Reality**	**Credits:** 2 **Allocated Hours:** 30 Hrs
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**
Course Outcome (COs): On completion of the course, the students will be able to		
CO1	Describe how AR systems work and list the applications of AR.	
CO2	Understand and analyse the hardware requirement of AR.	
CO3	Use computer vision concepts for AR and describe AR techniques	
CO4	Analyse and understand the working of various state of the art AR devices	
CO5	Acquire knowledge of mixed reality	
CO6	Design and formulate Virtual/Augmented Reality Applications	

Unit	Contents
I	**Introduction to VR and AR.** Virtual Reality and Virtual Environment, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark, Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, enhancing interactivity in AR Environments, Evaluating AR systems
II	**Virtual Reality Hardware and software.** Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR **#Exemplar/ Case Studies** GHOST (General Haptics Open Software Toolkit) software development toolkit.

III	**Augmented Reality Hardware** Augmented Reality Concepts- How Does Augmented Reality Work? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience. **#Exemplar/Case Studies** Timeline of evolution of AR from VR Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking and Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion. **#Exemplar/Case Studies**: Study the design of an AR application with C# and Unity **#Exemplar/Case Studies**: A virtual Study Use Case- NICE, An Educational Experience, https://virtualspeech.com/blog/examples-of-vr-used-for-training-industry-case-studies

Reference Books:

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.
4. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978- 1484236178
5. Augmented Reality: Principles and Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
6. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
7. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
8. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
9. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.
10. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016,

ISBN: 9781491962381

11. Sanni Siltanen- Theory and applications of marker-based augmented reality, Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0
12. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13 : 978-1838648183
13. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436

e-Books:

1. https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf
2. https://docs.microsoft.com/en-us/windows/mixed-reality/
3. http://lavalle.pl/vr/book.html

MOOC Courses:

1. https://nptel.ac.in/courses/106/106/106106138/
2. https://www.coursera.org/learn/introduction-virtual-reality
3. https://www.coursera.org/learn/ar
4. https://www.udemy.com/share/101XPi/
5. https://www.coursera.org/learn/augmented-reality

S.Y. M.Sc. Semester III		
ELS-656 **Elective-IV**	**Mechatronics**	**Credits:** 2 **Allocated Hours:** 30 Hrs
Allocated marks	**CE- 20 and ESE-30**	**Total = 50 Marks**

Course Outcome (COs): On completion of the course, the students will be able to	
CO1	Understand the Principles and Components of Mechatronic Systems.
CO2	Analyse and understand the working of various Sensors and Transducers
CO3	Design Mechanical Actuation Systems and understand the principles of operation and selection criteria for these components.
CO4	Design Electrical Actuation control circuits for actuating mechanical components in mechatronic systems.
CO5	Integrate mechanical and electrical components into mechatronic systems.
CO6	Analyze and Design Mechatronic Systems and propose solutions for real-world applications through case studies.

Unit	Contents
I	**Introduction to Mechatronics, Sensors and Transducers** **Introduction**: What is mechatronics, an overview of - the design process, various systems in mechatronics such as embedded systems, modeling systems, measurement systems, control systems, examples of mechatronic systems **Sensors and Transducers:** Introduction to sensors and transducers, sensitivity analysis, effect of component variation, measurement of motion, digital sensors for motion measurement, force, torque and tactile sensors, vibration- acceleration sensors, flow measurement, temperature sensors and devices, applications of sensors
II	**Mechanical and Electrical Actuation Systems** Mechanical actuation systems: mechanisms and their role in mechatronic systems, translational and rotational motion – degrees of freedom, kinematic chains – examples of links, toggle linkage, slider crank etc. cams, gears – types, gear trains, gear ratios, uses of rotation to- translational motion – rack and pinion, ball screw and links, Ratchet and pawl, belt and chain drives, bearings– types and uses, consideration of moment of inertia and torque for motor selection Electrical actuation systems: Relays and applications with driver circuits drives. **Mechatronic systems:** Mechatronic designs and case studies

Reference Books:

1. Mechatronics by W.Bolton, 4th Edition, Pearson.

2. Mechatronics System Design, by Devdas Shetty and Richard Kolk, 2nd Edition, Cengage Learning.

3. Robotics Engineering – An integrated approach. By Richard W. Klafter, Thomas A.

Chmielewski and Michael Negin, PHI Learning Pvt. Ltd.

S.Y. M.Sc. Semester III		
ELS-661	**Research Project-2**	**Credits:** 6
Allocated marks	**CE=60 and ESE=90**	**Total = 150 Marks**

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 III		
ELS -670	**Electronics Practical-VII**	**Credits:** 2 **Allocated Hours:** 4Hrs /week
Allocated marks	**CE-20 and ESE-30**	**Total = 50 Marks**
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

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.

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

ELS -654: RTOS (µCOS-II/FreeRTOS)

Sr. No	Experiment Title
1.	Multi-tasking
2.	Message queues
3.	Mail box
4.	Mutex
5.	Semaphores
6.	Memory Management

ELS -655: Augmented Reality and Virtual Reality (AR/VR)

Sr. No.	Experiment Title
1.	Installation of Unity and Visual Studio, setting up Unity for VR/AR development, understanding documentation of the same.
2.	Develop a scene in Unity that includes: a. A cube, plane and sphere, apply transformations on the 3 game objects. b. Add a video and audio source.
3.	Develop a scene in Unity that includes AR(Vuforia): a. Create a C# script which generated a rotation effect of different shapes (cube) when an image is scanned using AR App (use ARCore/Vuforia and Unity). b. Create a C# script which plays a video when an image is scanned using AR App (use ARCore/Vuforia and Unity).
4.	Demonstration of the working of HTC Vive/ Google Cardboard/ Google Daydream / Samsung gear VR
5.	Demonstration of the working of AR glasses and Google Cardboard.

ELS -656: Mechatronics

Sr. No.	Experiment Title
1.	Study of a DC servo motor
2.	Study of BLDC motor, its speed control/position control
3.	Study of PMDC motor torque speed characteristics
4.	Study of AC servo motor, its speed control/position control

5.	Implementation of velocity profile of servo control

Note: Any other equivalent experiment