Name of the course	**OPERATING SYSTEMS**
Course Code: **PC-ECS 501**	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: 2 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	Understand the fundamental principles and architecture of modern operating systems.
2.	Learn how operating systems manage hardware resources like CPU, memory, and I/O devices.
3.	Gain insight into process synchronization, inter-process communication, and deadlock handling.
4.	Acquire knowledge of memory management, file systems, and disk scheduling strategies.

Pre-Requisite:

1.	Programming for Problem Solving (ES-CS201)
2.	Data Structures & Algorithms (PC-ECS302)

Unit	Content	Hrs	Marks
1	Introduction: Generations Concept of Operating systems, Systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.	**6**	
2	Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.	**8**	
3	Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.	**7**	
4	Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock	**6**	

	detection and Recovery		
5	Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation– Fixed and variable partition– Internal and External fragmentation and Compaction; Paging: Principle of operation –Page allocation Hardware support for paging, Protection and sharing, Disadvantages of paging. Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault , Working Set , Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU)	**9**	
6	I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance. Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks	**9**	

Text books:

1. Operating System Concepts Essentials, 9th Edition by AviSilberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
3. Operating System Concepts, Ekta Walia, Khanna Publishing House (AICTE Recommended Textbook – 2018)
4. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
5. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, AddisonWesley
6. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India
7. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

Reference books:

Course Outcome:

After completion of this course, the learners will be able to

1. Describe the structure, services, and types of operating systems.
2. Analyze and simulate process management and CPU scheduling algorithms.
3. Apply inter-process communication and synchronization techniques to handle concurrency.
4. Explain and implement techniques for deadlock prevention, avoidance, and recovery.

5. Evaluate memory management schemes including paging and virtual memory.
6. Understand file systems, disk management, and I/O handling techniques in an OS.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**Power System**
Course Code: PC-ECS 502	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 2 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand the basic principle of generation of Electricity from different sources
2.	To find parameters and characteristics of overhead transmission lines and cables.
3.	To find different parameters for the construction of overhead transmission line
4.	To determine the performance of transmission lines.
5.	To understand the principle tariff calculation.
6	To solve numerical problems on the topics studied.

Pre-Requisite:

1.	Basic Electrical Engineering (ES-EE-101)
2.	Electric Circuit Theory (PC-ECS-301)

Unit	Content	Hrs	Marks
1	**Basic Concepts:** Evolution of Power System and present day Scenario. Structure of power system: Bulk power grid and Micro Grid. **Generation of Electric Power:** General layout of a typical coal fired power station, Hydro electric power station, Nuclear power station, their components and working principles, comparison of different methods of power generation. **Introduction to Solar & Wind energy system.** **Indian Electricity Rule-1956:** General Introduction	**10**	
2	**Overhead transmission line:** Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phase symmetrical and unsymmetrical configurations. Bundle conductors. **Transposition.** Concept of GMD and GMR. Influence of earth on conductor capacitance. **Overhead line construction:** Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag. Dampers. **Corona:** Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.	**12**	
3	**Insulators:** Types, Voltage distribution across a suspension insulator string,	**5**	

	String efficiency, Arching shield & rings, Methods of improving voltage distribution across Insulator strings, Electrical tests on line Insulators.		
4	**Cables:** Types of cables, cable components, capacitance of single core & 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.	**4**	
5	**Performance of lines:** Short, medium (nominal, T) and long lines and their representation. A.B.C.D constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.	**6**	
6	**Tariff:** Guiding principle of Tariff, different types of tariff.	**3**	

Text Books:

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power Systems, A. Ambikapathy, Khanna Publishing House
3. Power System Engineering, Nagrath & Kothery, TMH
4. Elements of power system analysis, C.L. Wodhwa, New Age International.
5. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors

Reference Books:

1. Electric Power transmission & Distribution, S.Sivanagaraju, S.Satyanarayana,, Pearson Education.
2. A Text book on Power system Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.
3. Electric Power distribution system Engineering, 2nd Edition, T. Gonen, CRC Press.
4. www.powermin.nic.in/acts_notification/pdf/ier1956.pdf

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of generation of Electric power from different sources
2. determine parameters of transmission lines and its performance
3. explain the principle of formation of corona and methods of its reduction
4. conduct electrical tests on insulators
5. solve numerical problems related to overhead transmission line, cable, insulators and tariff
6. analyze overhead transmission line based on short medium and long lines.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**MICROCONTROLLER & IT'S APPLICATION**
Course Code: **PC-ECS 503**	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: 2 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	Introduce the architecture and programming principles of microcontrollers.
2.	Develop understanding of memory organization, addressing modes, and instruction sets.
3.	Familiarize students with the 8051 and PIC microcontroller and its peripherals.
4.	Enable development of real-time embedded applications using microcontrollers.

Pre-Requisite:

1.	Analog & Digital Electronics (ES-ECS 301)
2.	Computer Org. & Architecture (PC-ECS 406)

Unit	Content	Hrs	Marks
1.	**Fundamentals of Microprocessor:** Compare microprocessor and microcontroller, Architecture of 8085 microprocessor, Pin details and functional operation of 8085	**4**	
2.	**Introduction to 8051 Architecture :** The 8051 Architecture- Hardware- Oscillator and clock-program counter – data pointer-registers-stack and stack pointer-special function registers-memory organization-program memory-data memory -Input / Output Ports –External memory counter and timer-serial data Input / output-Interrupts.	**10**	
3.	**8051 Programming in Assembly Language :** Basics of 8051 Assembly Language Programming, Different Addressing modes-Accessing memory using various addressing modes- – Instruction set- I/O Port Programs – bit level instructions and Programs –Timer and counters - and application Programs, Interrupt programming.	**10**	
2.	**Interfacing Microcontroller:** Programming 8051 Timers – Serial Port Programming – Interrupts Programming – LCD & Keyboard Interfacing – ADC, DAC & Sensor Interfacing – External Memory Interface- Stepper Motor and Waveform generation.	**6**	
3.	**PIC Microcontroller:** PIC16FXXX architecture, operation, data and program memory organization, special function registers, addressing modes, instruction set.	**6**	

Text books:

1. Myke Predko, "Programming and customizing the PIC microcontroller", 3rd Edition, Tata McGraw Hill Publishing Company Limited, 2008.

Reference books:

1. T. R. Padmanabhan, "Introduction to microcontrollers and applications", 1st Edition, Narosa publishing house private limited, 2007.
2. PIC Micro mid Range MCU Family Reference Manual - Micro Chip Technology Inc.

Course Outcome:

After completion of this course, the learners will be able to

1. Understand the concepts of microprocessors and microcontrollers.
2. Comprehend microcontroller architecture and instruction set.
3. Develop programs for different microcontroller.
4. Demonstrate real world applications through simulation and hardware.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**DIGITAL SIGNAL PROCESSING**
Course Code: PE- ECS 501A	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 0 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand sampling and reconstruction of signal.
2.	To understand the method of Z-transform and inverse Z- transform of signal and its properties.
3.	To understand Discrete Fourier Transform.
4.	To understand methods of design of Digital filters.
5.	To understand applications of Digital signal processing.
6.	To solve numerical problems on the topics studied.

Pre-Requisite:

1.	Electric circuit theory (PC-ECS 301)
2.	Control system (PC-ECS 502)

Unit	Content	Hrs	Marks
1	**Discrete-time signals and systems:** Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	**06**	
2	**Z-transform:** z-Transform, Region of convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z- transforms.	**06**	
3	**Discrete Fourier Transform :** Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.	**08**	
4	**Design of Digital filters:** Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band stop and High- pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.	**12**	
5	**Applications of Digital Signal Processing:** Correlation Functions and	**06**	

	Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.		

Text books:

1. Digital Signal Processing-A computer based approach, S. Mitra, TMH.
2. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis & M.G. Manslakis, PHI.
3. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.

Reference books:

1. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning.
2. Digital Signal Processing, Chen, OUP.
3. Digital Signal Processing, Johnson, PHI.
4. Digital Signal Processing using MATLAB, Ingle, Vikas.
5. Digital Signal Processing, Ifeachor, Pearson Education.
6. Digital Signal Processing, A.V. Oppenhein & R.W. Shaffer, PHI.
7. Theory and application of Digital Signal Processing, L.R. Rabiner & B. Gold, PHI.
8. Digital Signal Processing, Ashok Ambarder, Cengage Learning.
9. Digital Signal Processing, S. Salivahanan, A. Vallavaris & C. Gnanpruja, TMH.
10. Xilinx FPGA user manual and application notes.

Course Outcome:

After completion of this course, the learners will be able to

1. represent signals mathematically in continuous and discrete-time and in the frequency domain.
2. analyse discrete-time systems using z-transform.
3. explain the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. design digital filters for various applications.
5. apply digital signal processing for the analysis of real-life signals.

Special Remarks:

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**DIGITAL CONTROL SYSTEM**

Course Code: PE- ECS 501B	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 0 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand the principle of sampling and reconstruction of signals.
2.	To find Z-tranaform and inverse Z-transform of systems.
3.	To carry out the analysis and design of digital control systems
4.	To design compensators for digital control system to achieve desired specifications.
5.	To represent digital control systems using state space models.
6.	To analyze the effect sampling on stability, controllability and observability.
7.	To design digital controllers for industrial applications.
8.	To solve numerical problems on the topics studied

Pre-Requisite:

1.	Control system (PC-ECS 502)

Unit	Content	Hrs	Marks
1	**Sampling and reconstruction:** Introduction, Examples of Data control systems – Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.	**03**	
2	**Z-transform:** Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms.	**05**	
3	**Z- Plane analysis of discrete-time control system:** Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems mapping between s-plane and z-plane.	**05**	
4	**State space analysis:** State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete state space equations, State transition matrix and its Properties, Methods for Computation of State Transition Matrix, Discretization of continuous state space equations.	**06**	
5	**Controllability and observability:** Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.	**04**	
6.	**Stability analysis:** Mapping between the S-Plane and the Z-Plane –	**05**	

	Primary strips and Complementary Strips Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.		
7.	**Design of discrete time control system by conventional methods:** Transient and steady-State response Analysis Design based on the frequency response method Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers.	**06**	
8.	**State feedback controllers and observers:** Design of state 05 feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.	**06**	

Text books:

1. Digital Control and State Variable Methods , M. Gopal, TMH Publishers
2. Discrete-time Control Systems, K. Ogata, Pearson Education
3. Digital Control Systems, B.C. Kuo, Wiley Publications.
4. Control System Engineering, I.J. Nagrath, M. Gopal, New age International.

Reference books:

1. Digital control of dynamic systems, Gene F. Franklin, J. David Powell, and Michael Workman 3rd ed, 1998, Addison-Wesley.
2. Digital Control Systems, design, identification and implementation, Landau, Ioan Doré, Zito, Gianluca, Springer-Verlag London.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of sampling and reconstruction of analog signal.
2. perform Z-transformation and inverse Z-transformation of systems.
3. analyse and design digital control systems.
4. design compensators for digital control system to achieve desired specifications.
5. represent digital control systems using state space models.
6. analyze the effect sampling on stability, controllability and observability.

Special Remarks:

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**ELECTRICAL AND HYBRID TRANSPORTATION**
Course Code: PE- ECS 501C	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 0 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand the basic difference between conventional and Hybrid vehicles.
2.	To understand different configuration and control of Electric drives.
3.	To understand energy storage system in Hybrid vehicles.
4.	To understand different energy management strategies of Hybrid vehicles.
5.	To solve numerical problems on the topics studied

Pre-Requisite:

1.	Electric Machines (PC-ECS 401)

Unit	Content	Hrs	Marks
1	**Introduction:** Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. 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. 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.	**09**	
2	**Electric Trains:** Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain 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, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	**10**	
3	**Energy Storage: Energy Storage:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal	**09**	

	combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems		
4	**Energy Management Strategies:** 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, implementation issues of energy management strategies.	**06**	
5	**Case Studies:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	**05**	
6.	**Drone:** Introduction to Drones, History and Evolution of Drones, Early developments, Modern advancements, Types of Drones, Fixed-wing, Rotary-wing (Multicopters), Hybrid, Applications of Drones: Agriculture, Surveillance and Security, Mapping and Surveying, Photography and Videography, Industrial Inspections	**03**	

Text books:

1. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press.
2. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons.
3. Hybrid Electric Vehicles: Energy Management Strategies, Onori Simona, Serrao Lorenzo and Rizzoni Giorgio, Springer.
4. Electric and Hybrid Vehicles, T. Denton, Routledge.

Reference books:

1. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi CRC Press, 2004.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of Electric traction.
2. choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
3. design and develop basic schemes of electric vehicles and hybrid electric vehicles.
4. choose proper energy storage systems for vehicle applications
5. implement different energy management strategies for hybrid vehicle.

Special Remarks:

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**STATISTICS AND FOUNDATIONS OF DATA SCIENCE**
Course Code: **OE-ECS 501 A**	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: 2 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand the foundational concepts in data science, linear algebra, and statistical inference.
2.	To gain knowledge of data preprocessing and exploration techniques.
3.	To apply basic machine learning algorithms for classification and clustering.
4.	To develop effective skills in feature selection and data visualization for real-world datasets

Pre-Requisite:

1.	Mathematics – II (BS-M202)
2.	Programming for Problem Solving (ES-CS201)
3.	Data Structures & Algorithms (PC-ECS 302)

Unit	Content	Hrs	Marks
1.	Introduction: Data Science. Big Data and Data Science – Datafication – Current landscape of perspectives – Skill sets needed; Matrices – Matrices to represent relations between data, and necessary linear algebraic operations on matrices -Approximately representing matrices by decompositions (SVD and PCA); Statistics: Descriptive Statistics: distributions and probability – Statistical Inference: Populations and samples – Statistical modeling – probability distributions – fitting a model – Hypothesis Testing .	**9**	
2.	Data preprocessing: Data cleaning – data integration – Data Reduction Data Transformation and Data Discretization. Evaluation of classification methods – Confusion matrix, Students T-tests and ROC curves-Exploratory Data Analysis – Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA – The Data Science Process.	**8**	
3.	Basic Machine Learning Algorithms: Association Rule mining – Linear Regression- Logistic Regression – Classifiers – k-Nearest Neighbors (k-NN), k-means -Decision tree – Naive Bayes- Ensemble Methods – Random Forest. Feature Generation and Feature Selection – Feature	**10**	

	Selection algorithms – Filters; Wrappers; Decision Trees; Random Forests.		
4.	Clustering: Choosing distance metrics – Different clustering approaches – hierarchical agglomerative clustering, k-means (Lloyd's algorithm), – DBSCAN – Relative merits of each method – clustering tendency and quality.	**7**	
5.	Data Visualization: Basic principles, ideas and tools for data visualization.	**6**	

Text books:

1. Cathy O'Neil and Rachel Schutt, " Doing Data Science, Straight Talk From The Frontline", O'Reilly, 2014.
2. Jiawei Han, Micheline Kamber and Jian Pei, " Data Mining: Concepts and Techniques", Third Edition. ISBN 0123814790, 2011.
3. Mohammed J. Zaki and Wagner Miera Jr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014.

Reference books:

1. Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , O'Reilly, 2016.
2. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015.
3. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, 2012.

Course Outcome:

After completion of this course, the learners will be able to

1. Understand key statistical and algebraic foundations of data science.
2. Perform data cleaning, preprocessing, and exploratory data analysis effectively.
3. Apply and evaluate basic machine learning and clustering algorithms.
4. Select relevant features and visualize data for insightful interpretation and decision-making.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**VLSI & MICROELECTRONICS**
Course Code: OE-ECS 501B	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: 2 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	Understand semiconductor fundamentals and MOSFET operation.
2.	Learn about digital and analog VLSI design methodologies.
3.	Gain knowledge of CMOS technology, fabrication, and layout design.
4.	Develop skills in VLSI testing and verification.
5.	Explore applications of microelectronics in modern devices.

Pre-Requisite:

1.	Analog & Digital Electronics (ES-ECS 301)

Unit	Content	Hrs	Marks
1.	**Introduction to Microelectronics & VLSI:** Evolution of Microelectronics and VLSI, Moore's Law and Scaling Trends, Applications of VLSI in Modern Electronics, VLSI Design Flow: Front-end vs. Back-end Design, Types of ICs: SSI, MSI, LSI, VLSI, ULSI	**3**	
2.	**Semiconductor Physics & MOSFETs:** Semiconductor Basics: Doping, Carrier Concentration, PN Junctions, MOS Capacitor: Structure and Characteristics, MOSFET Structure and Operation, Threshold Voltage, Channel Formation, Subthreshold Conduction, Short-Channel Effects, Scaling of MOSFETs	**6**	
3.	**CMOS Technology & Fabrication:** CMOS Logic: Inverter, NAND, NOR, XOR, Transmission Gates, CMOS Fabrication Process: Oxidation, Lithography, Doping, Etching, CMOS Process Integration: Twin-Well, SOI, FinFET, Layout Design Rules: Lambda-Based Design, Design for Manufacturability (DFM) and Yield Considerations	**6**	
4.	**Digital VLSI Design:** Combinational and Sequential Circuit Design using CMOS, Static & Dynamic Power Dissipation in CMOS Circuits, Design of Flip-Flops, Latches, Registers, Counters, Clocking Strategies: Skew, Jitter, Clock Distribution Networks, Power Optimization Techniques: Clock	**8**	

	Gating, Multi-Vt Design		
5.	**Analog & Mixed-Signal VLSI Design:** Introduction to Analog CMOS Design, Design of Current Mirrors, Differential Amplifiers, Operational Amplifiers: Two-Stage, Cascode, Folded Cascode, Data Converters: ADC, DAC Architectures, Phase-Locked Loops (PLL) and Frequency Synthesizers	**7**	
6.	**VLSI Testing & Verification:** Fault Modeling: Stuck-at, Bridging, Delay Faults, Design for Testability (DFT): Scan Chains, BIST, ATPG (Automatic Test Pattern Generation), Logic Simulation, Timing Analysis, VLSI CAD Tools: SPICE, Cadence, Synopsys, Mentor Graphics	**6**	
7.	**Emerging Trends in VLSI & Microelectronics:** Low-Power VLSI & Beyond CMOS Technologies, 3D ICs & System-on-Chip (SoC) Design, MEMS & Nanoelectronics Applications, AI & ML in VLSI Design Automation, Quantum Computing & Cryogenic Electronics	**4**	

Text books:

1. "CMOS VLSI Design: A Circuits and Systems Perspective" – Neil Weste & David Harris
2. "Microelectronic Circuits" – Adel Sedra & Kenneth Smith
3. "Digital Integrated Circuits: A Design Perspective" – Jan M. Rabaey
4. SPICE Simulation Guide (Cadence, Synopsys)
5. FPGA & Verilog Documentation (Xilinx, Intel)

Reference books:

Course Outcome:
After completion of this course, the learners will be able to

1. Understand the evolution and design process of VLSI systems.
2. Apply CMOS technology to design digital and analog circuits.
3. Perform testing and verification of VLSI circuits using industry-standard tools.
4. Analyze and explore emerging trends and applications in VLSI and microelectronics.

Special Remarks:
The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**MECHATRONICS**
Course Code: OE-ECS 501C	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: 2 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To provide foundational knowledge of electrical circuits and signal conditioning used in mechatronic systems.
2.	To introduce control system and power electronics relevant to designing intelligent systems.
3.	To enable understanding of integration between mechanical, electronic, and computer control systems.
4.	To develop the ability to analyze and design basic mechatronic applications.

Pre-Requisite:

1.	Control Systems (PC-ECS 502)
2.	Electric Machines (PC-ECS 401)
3.	Analog & Digital Electronics (ES-ECS 301)

Unit	Content	Hrs	Marks
1.	Introduction to Mechatronics: Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering	**3**	
2.	Review of fundamentals of electronics: Logic gates and their operations, Signal processing devices, Data conversion devices, Input and output devices. Sensors and Transducers, Actuators, Limit switches, Relays	**6**	
3.	Control Systems: Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms.	**3**	
4.	Electrical Drives: Stepper motors, servo drives.	**2**	
5.	Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems.	**3**	
6.	Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc.	**4**	
7.	Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple	**5**	

	assembly and mnemonic programming on 8085 microprocessor.		
8.	Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram.	**4**	
9.	Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotory motion and its Laplace Transform.	**2**	
10.	Basics of time domain analysis, Introduction to discrete-time systems and Z-transform.	**2**	
11.	Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc.	**2**	

Text books:

1. W. Bolton, Mechatronics, 5th Edition, Addison Wesley Longman Ltd., 2010.
2. D. Shetty and R. Kolk, Mechatronics System Design, 3rd Edition, PWS Publishing, 2009.
3. D.G. Alciatore & M.B. Histand, Introduction to Mechatronics and Measurement systems, 4th Edition, McGraw Hill, 2006.
4. A. Smaili and F. Arnold, Applied Mechatronics, Oxford University Press, Indian Edition, 2007.
5. M.D. Singh and J.G. Joshi, Mechatronics, Prentice Hall of India, 2006.
6. K.K. Appu Kuttan, Introduction to Mechatronics, Oxford University Press, New Delhi, 2007.
7. HMT Ltd., Mechatronics, McGraw Hill Publication, 2017.
8. F.H. Raven, Automatic Control Engineering, McGraw Hill India, 2013.
9. K. Ogata, Modern Control Engineering, Prentice Hall, 2010.
10. B.C. Kuo, Automatic Control Systems, Prentice Hall, 1975.
11. A. Ambikapthy, Control Systems, Khanna Publishing House, 2015.

Reference books:

Course Outcome:

After completion of this course, the learners will be able to

1. Model and analyze mechatronic systems for an engineering application
2. Identify sensors, transducers and actuators to monitor and control the behavior of process or product.
3. Develop PLC programs for an engineering application.
4. Evaluate the performance of mechatronic systems.
5. solve numerical problems on LTI system modelling, responses, error dynamics and stability .

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**UNIVERSAL HUMAN VALUES**
Course Code: OE-ECS 502A	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: Nil	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To help students understand the need, basic guidelines, content, and process of value education.
2.	To enable students to understand harmony at all levels of human existence and the implications of living in harmony.
3.	To facilitate the development of a holistic perspective towards life and profession.
4.	To inspire students to become responsible citizens with ethical and humanistic values.

Pre-Requisite:

1.	Environmental Science (MC-ECS101)
2.	Constitution of India (MC-ECS201)

Unit	Content	Hrs	Marks
1.	**Introduction to Value Education:** Right Understanding; Relationship and Physical Facility; Understanding Value Education; Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity -the Basic Human Aspiration-Current Scenario and Method to Fulfill the Basic Human Aspirations.	**10**	
2.	**Harmony in the Human Being:** Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.	**10**	
3.	**Harmony in the Family and Society and Nature:** Harmony in the Family – the Basic Unit of Human Interaction; 'Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation: Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order; Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature.	**10**	
4.	**Implications of the Holistic Understanding – a Look at Professional Ethics** Definitiveness of (Ethical) Human Conduct; A Basis for Humanistic	**8**	

	Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics; Holistic Technologies, Production Systems and Management Models; Strategies for Transition towards Value-based Life and Profession		

Text books:

1. *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G P Bagaria,2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for *A Foundation Coursein Human Valuesand Professional Ethics*, R R Gaur, R Asthana,G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978- 93- 87034-53-2
3. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999.
4. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi,2004.

Course Outcome:

After completion of this course, the learners will be able to

1. Explore holistic vision of life - themselves and their surroundings.
2. Develop competence and capabilities for maintaining Health and Hygiene.
3. Analyse various problems in life, family, Society and in handling problems with Sustainable Solutions.
4. Apply values to their own self in different day-to-day settings in real life and in handling problems with sustainable solutions.
5. Adopt the value of appreciation and aspiration for excellence and gratitude for all.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**SOFT SKILL & INTERPERSONAL COMMUNICATION**
Course Code: OE-ECS 502B	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: Nil	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To develop students' verbal and non-verbal communication skills to effectively convey and interpret messages.
2.	To enhance students' written communication, especially in professional settings.
3.	To expose students to literary texts that enrich vocabulary and emotional intelligence.
4.	To improve grammar usage and language application through contextual learning.

Pre-Requisite:

1.	English (HM-HU201)
2.	Language Laboratory (HM-HU291)

Unit	Content	Hrs	Marks
1.	Communication Skill Definition, nature & attributes of Communication Process of Communication Models or Theories of Communication Types of Communication Levels or Channels of Communication Barriers to Communication	**3**	
2.	Business Communication- Scope & Importance Writing Formal Business Letters Writing Reports Organizational Communication: Agenda & minutes of a meeting, notice, memo, circular Project Proposal Technical Report Writing Organizing e-mail messages E-mail etiquette Tips for e-mail effectiveness	**8**	
3.	Language through Literature Modes of literary & non-literary expression Introduction to Fiction, (An Astrologer's Day by R.K. Narayan and Monkey's Paw by W.W. Jacobs), Drama (The Two Executioners by Fernando Arrabal) or (Lithuania by Rupert Brooke) & Poetry (Night of the Scorpion by Nissim Ezekiel and Palanquin Bearers by Sarojini Naidu)	**8**	
4.	Grammar in usage (nouns, verbs, adjectives, adverbs, tense, prepositions, voice change) - to be dealt with the help of the given texts.	**10**	

Text books:

1. Mattelart, A., & Mattelart, M. (n.d.). Theories of communication: A short introduction. Sage Publications Ltd.
2. Chan, J. F., & Lutovich, D. (1997). Professional writing skills. San Anselmo, CA: Advanced Communication Designs.
3. Kumar, K. (n.d.). Effective business communications. Khanna Publishing House.
4. Bailey, E. P. (n.d.). Writing and speaking at work: A practical guide for business communication. Prentice-Hall.
5. Chaney, L., & Martin, J. (n.d.). Intercultural business communication. Prentice Hall.

Course Outcome:

After completion of this course, the learners will be able to

1. Analyse the dynamics of business communication and communicate accordingly.
2. Write business letters and reports
3. Learn to articulate opinions and views with clarity
4. Appreciate the use of language to create beautiful expressions
5. Analyse and appreciate literature.
6. Communicate in an official and formal environment.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**ORGANIZATIONAL BEHAVIOR**
Course Code: OE-ECS 502C	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: Nil	Assignment & Quiz: 10 Marks
Practical: Nil	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To introduce students to the fundamentals of human behavior in organizations.
2.	To develop insights into how personal and group dynamics influence organizational effectiveness.
3.	To explore leadership, motivation, perception, and communication within organizational settings.
4.	To examine organizational structure, conflict, and political behavior impacting individual and group performance.

Pre-Requisite:

1.	Economics for Engineers (HM 301)
2.	Universal Human Values (OE-ECS 502 A)

Unit	Content	Hrs	Marks
1.	Organizational Behaviour: Definition, Importance, Historical Background, Fundamental Concepts of OB, Challenges and Opportunities for OB. Personality and Attitudes: Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction.	**4**	
2.	Perception: Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making. 4. Motivation: Definition, Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory.	**8**	
3.	Group Behaviour: Characteristics of Group, Types of Groups, Stages of Group Development, Group Decision Making. Communication: Communication Process, Direction of Communication, Barriers to Effective Communication. Leadership: Definition, Importance, Theories of Leadership Styles.	**4**	
4.	Organizational Politics: Definition, Factors contributing to Political Behaviour. Conflict Management: Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation – Bargaining Strategies, Negotiation Process. Organizational Design:	**8**	

	Various Organizational Structures and their Effects on Human Behaviour, Concepts of Organizational Climate and Organizational Culture.		

Text books:

1. Robbins, S. P. & Judge, T.A.: Organizational Behavior, Pearson Education, 15th Edn.
2. Luthans, Fred: Organizational Behavior, McGraw Hill, 12th Edn.
3. Shukla, Madhukar: Understanding Organizations – Organizational Theory & Practice in India, PHI
4. Fincham, R. & Rhodes, P.: Principles of Organizational Behaviour, OUP, 4th Edn.
5. Hersey, P., Blanchard, K.H., Johnson, D.E.- Management of Organizational Behavior Leading Human Resources, PHI, 10th Edn.

Course Outcome:

After completion of this course, the learners will be able to

1. Understand the impact of individual and group behavior on organizational performance.
2. Apply motivation and leadership theories in managing human resources.
3. Analyze group dynamics and communication strategies in workplace scenarios.
4. Evaluate and manage organizational conflict, culture, and political behavior.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**OPERATING SYSTEM LABORATORY**
Course Code: **PC-ECS 591**	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: Nil	Continuous Internal Assessment:40
Tutorial: Nil	External Assessment: 60
Practical: 2 hrs/week	
Credit Points: 1	

	Laboratory Experiments:
1	Managing Unix/Linux Operating System [8P]: Creating a bash shell script, making a script executable, shell syntax (variables, conditions, control structures, functions, commands). Partitions, Swap space, Device files, Raw and Block files, Formatting disks, Making file systems, Superblock, I-nodes, File system checker, Mounting file systems, Logical Volumes, Network File systems, Backup schedules and methods Kernel loading, in it and the in ittab file, Run-levels, Run level scripts. Password file management, Password security, Shadow file, Groups and the group file, Shells, restricted shells, user-management commands, homes and permissions, default files, profiles, locking accounts, setting passwords, Switching user, Switching group, Removing users &user groups.
2	Process [4P]: starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process
3	Signal [4P]: signal handling, sending signals, signal interface, signal sets
4	Semaphore [6P]: programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v).
5.	POSIX Threads [6P]: programming with pthread functions (viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel)
6.	Inter-process communication [6P]: pipes(use functions pipe, popen, pclose), namedpipes(FIFOs, accessing FIFO), message passing & shared memory(IPC version V).

Course Outcome:

After completion of this course, the learners will be able to

1. Gain hands-on experience in managing Unix/Linux operating systems through scripting, file systems, and user management tasks.
2. Understand process management, including creation, duplication, and management of processes in a Unix/Linux environment.
3. Learn signal handling, process synchronization, and communication mechanisms within an operating system.
4. Develop proficiency in inter-process communication techniques using semaphores, pipes, message passing, and shared memory.

5. Apply POSIX thread programming to design and manage concurrent execution of tasks in an operating system.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**Power System Laboratory**
Course Code: PC-ECS 592	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: Nil	Continuous Internal Assessment:40
Tutorial: Nil	External Assessment: 60
Practical: 2 hrs/week	
Credit Points: 1	

	Laboratory Experiments:
1	Determination of the generalized constants A.B,C,D of long transmission line and regulation of a 3-Φ transmission line model
2	Study of distribution system by network analyzer.
3	Measurement of earth resistance by earth tester.
4	Determination of dielectric strength of insulating oil.
5	Determination of breakdown strength of solid insulating material
6	Determination of parameter of 3-Φtransmission line model by power circle diagram
7	Study of different types of insulator.
8	Study of active and reactive power control of alternator.
9	Studyandanalysisofanelectricaltransmissionlinecircuitwiththehelpofsoftware
10	Determination of dielectric constant, tan delta, resistivity of transformer oil.

Course Outcome:

After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.
3. construct circuits with appropriate instruments and safety precautions.
4. validate different characteristics of transmission line.
5. determine earth resistance, dielectric strength of insulating oil, breakdown strength of solid insulating material and dielectric constant of transformer oil.
6. analyze an electrical transmission line circuit with the help of software
7. work effectively in a team

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**MICROCONTROLLER & IT'S APPLICATION LABORATORY**
Course Code: PC-ECS 593	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: Nil	Continuous Internal Assessment:40
Tutorial: Nil	External Assessment: 60
Practical: 2 hrs/week	
Credit Points: 1	

	Laboratory Experiments:
1	Interpret details of Hardware kit for Microcontroller and practice to write and execute programs.
2	Identify different menus available in a simulator software RIDE/KEIL and demonstrate their use.
3	Develop and execute Assembly language programs using Arithmetic Instructions and demonstrate outcome for a given input data.
4	Develop and execute Assembly language programs using Logical Instructions and demonstrate outcome for a given input.
5.	Develop and execute an Assembly language program for Addition of series of 8 bit nos, 16 bit result and demonstrate outcome for a given input data.
6.	Develop and execute Assembly language program for addition/subtraction of 16 bit no/multibyte nos. and demonstrate outcome for a given input data.
7.	Develop and execute Assembly language program for Block transfer from and to Internal/External memory using directives and demonstrate outcome for a given input data.
8.	Develop and execute Assembly language program Largest/smallest of given series of no. from Internal/External memory and demonstrate outcome for a given input data.
9.	Develop and execute Assembly language program arrange no in ascending/descending order from Internal/External memory and demonstrate outcome for a given input data.
10.	Develop and execute Assembly language program for LED blinking/LED sequences using delay/timer mode.
11.	Develop and execute Assembly language program to interface LED with microcontroller
12.	Develop and execute Assembly language program to interface STEPPER MOTOR with microcontroller

Course Outcome:

After completion of this course, the learners will be able to

1. Interpret the salient features of various types of microcontrollers.
2. Interpret the salient features of architype of types microcontrollers IC 8051.

3. Maintain the program features of the Microcontroller based application.
4. Develop assembly language program.
5. Develop programs to interface 8051 microcontrollers with LED/SWITCH/MOTOR.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**DATA SCIENCE LABORATORY**
Course Code: **OE-ECS 591 A**	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: Nil	Continuous Internal Assessment:40
Tutorial: Nil	External Assessment: 60
Practical: 2 hrs/week	
Credit Points: 1	

	Laboratory Experiments:
1	Introduction to Data Science Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting
2	Introduction to Programming Tools for Data Science 2.1 Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK 2.2 Visualizing Data: Bar Charts, Line Charts, Scatterplots 2.3 Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction
3	Mathematical Foundations 3.1 Linear Algebra: Vectors, Matrices, 3.2 Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation 3.3 Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem 3.4 Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Phacking, Bayesian Inference
4	Machine Learning Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural NetworksLearning And Generalization, Overview of Deep Learning.
5.	Case Studies of Data Science Application Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

1. Write a programme in Python to predict the class of the flower based on available attributes.
2. Write a programme in Python to predict if a loan will get approved or not.
3. Write a programme in Python to predict the traffic on a new mode of transport.
4. Write a programme in Python to predict the class of user.
5. Write a programme in Python to indentify the tweets which are hate tweets and which are not.

6. Write a programme in Python to predict the age of the actors.
7. Mini project to predict the time taken to solve a problem given the current status of the user.

Course Outcome:

After completion of this course, the learners will be able to

1. Demonstrate understanding of data science concepts and techniques including web scraping, big data traits, and data analysis vs reporting.
2. Use programming tools like Python (Matplotlib, NumPy, Scikit-learn, NLTK) to process, analyze, and visualize data through various graphical representations.
3. Apply mathematical foundations such as linear algebra, statistics, and probability to analyze and infer data patterns and relationships.
4. Implement machine learning algorithms for classification, regression, and clustering, including methods like Naïve Bayes, K-Nearest Neighbors, and support vector machines.
5. Analyze time-series data and apply advanced techniques like Bayesian inference, regularization methods, and neural networks for deep learning.
6. Apply data science methods to real-world case studies, including weather forecasting, stock market prediction, object recognition, and sentiment analysis.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**VLSI & MICROELECTRONICS**
Course Code: OE-ECS 591B	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: Nil	Continuous Internal Assessment:40
Tutorial: Nil	External Assessment: 60
Practical: 2 hrs/week	
Credit Points: 1	

	Laboratory Experiments:
1	**Semiconductor Device & MOSFET Characterization** • Measure I-V characteristics of NMOS and PMOS transistors. • Extract threshold voltage (Vt) and transconductance (gm) of MOSFETs. • Study the impact of channel length modulation and body effect on MOSFET behavior.
2	**CMOS Logic Gate Design & Simulation** • Design and simulate CMOS inverter, NAND, NOR gates. • Compare static and dynamic power dissipation of CMOS logic gates. • Perform layout design & DRC/LVS checks for CMOS logic gates.
3	**Combinational & Sequential Circuit Design using Verilog** • Implement 4-bit ALU using Verilog. • Design a 4-bit ripple carry adder & carry-lookahead adder. • Implement and simulate Flip-Flops (D, JK, T) and Shift Registers. • FPGA-based implementation of 8-bit counter & traffic light controller.
4	**Layout Design & Simulation of Digital Circuits** • Layout design of CMOS inverter with different transistor sizes. • Design and optimize SRAM memory cell layout. • Study the effect of parasitics (capacitance, resistance) on delay.
5.	**Analog VLSI Circuit Design** • Design & simulate Current Mirror & Differential Amplifier. • Implement a Two-Stage CMOS Operational Amplifier. • Study frequency response & gain-bandwidth product (GBW) of amplifiers.
6.	**VLSI Testing & Fault Analysis** • Perform fault modeling (stuck-at, bridging, delay faults). • Implement Scan Chain & Built-in Self-Test (BIST) techniques. • Generate Automatic Test Patterns (ATPG) for logic circuits.
7.	**Low-Power VLSI Design & Optimization** • Implement clock gating in a sequential circuit to reduce power.

	• Analyze power dissipation (static vs. dynamic) in CMOS circuits. • Perform Multi-Vt and Power-Gating techniques.
8.	**FPGA-Based Digital Design & Prototyping** • Implement Vending Machine Controller using FSM in Verilog. • Design a Digital Temperature Sensor Interface using FPGA. • Build a UART Communication System on FPGA.
9.	**Data Converters: ADC & DAC Implementation** • Design & simulate Successive Approximation ADC. • Implement R-2R Ladder DAC circuit. • Study the impact of quantization error and resolution.
10.	**System-on-Chip (SoC) & 3D IC Design (Advanced)** • Implement ARM-based SoC design with AXI Interconnect. • Study the impact of Through-Silicon Vias (TSVs) in 3D ICs.

Course Outcome:

After completion of this course, the learners will be able to

1. Analyze the electrical characteristics of MOSFETs and understand the influence of device parameters such as threshold voltage and body effect.
2. Design and simulate CMOS logic gates, combinational, and sequential circuits using Verilog and perform layout verification (DRC/LVS).
3. Implement and verify digital circuits on FPGA platforms including ALUs, counters, and finite state machines (FSMs).
4. Design analog VLSI building blocks such as current mirrors and operational amplifiers, and evaluate their performance metrics.
5. Apply VLSI testing techniques including fault modeling, ATPG, scan chains, and BIST for reliable circuit validation.
6. Implement low-power design strategies and study advanced topics like ADC/DAC architecture, SoC integration, and 3D IC design.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**MECHATRONICS**
Course Code: OE-ECS 591C	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	**Examination Scheme**
Theory: Nil	Continuous Internal Assessment:40
Tutorial: Nil	External Assessment: 60
Practical: 2 hrs/week	
Credit Points: 1	

	Laboratory Experiments:
1	Introduction to Mechatronics
2	Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion
3	Stepper motor interface
4	Traffic light interface.
5.	Speed control of DC motor.
6.	Study of various types of transducers.
7.	Study of hydraulic, pneumatic and electro-pneumatic circuits.
8.	Modelling and analysis basic hydraulic, pneumatic and electrical circuits using software.
9.	Study of PLC and its applications.
10.	Study of image processing

Course Outcome:

After completion of this course, the learners will be able to

1. Understand the fundamentals of mechatronic systems and their multidisciplinary nature.
2. Develop basic assembly language programs for 8085 microprocessor to perform arithmetic and logical operations.
3. Interface and control electromechanical actuators like stepper motors and DC motors.
4. Design and simulate basic automation systems such as traffic light controllers and motor speed regulators.
5. Analyze and implement fluid power systems using hydraulic, pneumatic, and electro-pneumatic circuits.
6. Explore programmable logic controllers (PLCs) and image processing techniques for industrial automation applications.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.