<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Teaching Scheme Hours /Week</th>
<th>Examination Scheme</th>
<th>Marks</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>20IN501</td>
<td>Process Loop Components</td>
<td>3 0 0</td>
<td>50 50 0 0</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>20IN502</td>
<td>Digital Signal Processing</td>
<td>3 1 0</td>
<td>50 50 0 0</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>20IN503</td>
<td>Internet of Things (IoT)</td>
<td>3 1 0</td>
<td>50 50 0 0</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>20PEIN501</td>
<td>Programme Elective-I</td>
<td>3 0 0</td>
<td>50 50 0 0</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>20PEIN502</td>
<td>Programme Elective-II*</td>
<td>3 0 0</td>
<td>50 50 0 0</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>20OEHS501</td>
<td>Open HS Elective –I</td>
<td>3 0 0</td>
<td>50 50 0 0</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>20IN501L</td>
<td>Process Loop Components Lab</td>
<td>0 0 2</td>
<td>25 0 0 25</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>20IN502L</td>
<td>Digital Signal Processing Lab</td>
<td>0 0 2</td>
<td>25 0 0 25</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>20PEIN501L</td>
<td>Programme Elective Lab-I</td>
<td>0 0 2</td>
<td>25 0 25 0</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>20AC501</td>
<td>Audit Course</td>
<td>0 0 2</td>
<td>0 0 0 0 0</td>
<td>0</td>
<td>No Credit</td>
</tr>
</tbody>
</table>

| Total      | 18 2 8 375 300 25 50 | 750 | 750 | 23 |
| Grand Total| 28 750 750 | 23 |

* NPTEL/Swayam Course

**Programme Elective-I**
- 20PEIN501A Modern Control Theory
- 20PEIN501B Biomedical and Analytical Instrumentation
- 20PEIN501C Advanced Micro controller Techniques

**Programme Elective-I Lab**
- 20PEIN501LA Modern Control Theory
- 20PEIN501LB Biomedical and Analytical Instrumentation
- 20PEIN501LC Advanced Micro controller Techniques
### Open Elective I (Humanities)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20OEHS501A</td>
<td>Entrepreneurship Development</td>
</tr>
<tr>
<td>2</td>
<td>20OEHS501B</td>
<td>Intellectual Property Rights</td>
</tr>
<tr>
<td>3</td>
<td>20OEHS501C</td>
<td>Introduction to Digital Marketing</td>
</tr>
<tr>
<td>4</td>
<td>20OEHS501D</td>
<td>Law for Engineers</td>
</tr>
<tr>
<td>5</td>
<td>20OEHS501E</td>
<td>Organizational Behaviour</td>
</tr>
<tr>
<td>6</td>
<td>20OEHS501F</td>
<td>Project Management</td>
</tr>
</tbody>
</table>
20IN501 Process Loop Components

Teaching Scheme:
Lectures: 3 Hrs /week

Examination Scheme:
In semester: 50 Marks
End semester: 50 Marks
Credit: 3

Prerequisites: Sensors and transducers, pneumatic flapper nozzle system, op amp circuits

Course Objectives:
1. To understand the different types of systems and basics of process control.
2. To explain the need, construction, working, types of process control components
3. Develop process control circuits/loops for various applications using standard symbols and notations
4. To demonstrate PLC programming skill for industrial applications

Course Outcomes: the students will be able to,
1. Delineate the working of different process control components.
2. Compare to select different process control components for various applications.
3. Analyse the performance of the process control components with respect to calibration, configuration, tuning.
4. Develop process control circuits/loops and PLC programs for various industrial applications using standard symbols and notations.

Unit 1: Types of systems and process control components (08)
Introduction to different types of systems, process control components related to different types of systems like switches, contactors, miniature circuit breaker, relays, actuators, FRL, Relief/safety valve, DCV, NRV etc, and applications.

Unit 2: Process Control Fundamentals (07)
Elements of process control loop, Types of process variables, Representation of process loop components using standard symbols (basics with reference to control loop), P & ID for temperature, flow, level, pressure process loops, Process Characteristics like process load, plant lags, dead time, capacity and regulation. Auxiliary components like alarm annunciator.

Unit 3: Transmitters and Converters (06)
Need of transmitter (concept of field area & control room area), Need for standardization of signals, Current, voltage, and pneumatic signal standards, Concept of live & dead zero, Types of transmitters (Two and four wire transmitters), Types, mounting (Installation), manifold, calibration setup, of electronic Differential Pressure Transmitter (DPT). DPT for Level measurement, zero elevation, zero suppression, Square root extractor, Block schematic and calibration of Smart transmitter, Comparison of SMART with conventional transmitter, Difference between converter and transmitter, Converters like Current to pressure converter and Pressure to current converter. 
Unit 4: Controllers
Discontinuous (Two position, time-proportional), Continuous controllers (Proportional, Integral, Derivative, Proportional-Integral, Proportional-Derivative, Proportional-Integral-Derivative (PID), Reset windup, Anti reset windup, Rate before reset, Bump less transfer, Effect of process characteristics on PID combination, Tuning of controllers, Block schematic and face plate of digital controllers, Position and Velocity algorithms

Unit 5: Programmable Logic Controller
Continuous versus Discrete Process Control, Limitations of relay based system, PLC architecture, Types of Input & Output modules, Fixed & Modular PLC, Interfacing pneumatic systems to PLC, PLC specifications, PLC manufacturers, PLC Basic instructions, Timers & Counters, PLC programming languages, Ladder programming for process applications

Unit 6: Control valve
Parts of pneumatic control valve, Control valve terminologies, Inherent and Installed control valve characteristics, types of control valves, Control valve selection criteria, Control valve accessories, types of actuators, Introduction to Control valve sizing and cavitation and flashing

Text Books:

Reference Books:
1. Armando B. Corripio, “Tuning of industrial control systems”, ISA.
2. James W. Hutchinson, “Control valve Handbook”, ISA
20IN502 Digital Signal Processing

Teaching Scheme:
Lectures: 3 Hrs/Week
Tutorial: 1 Hr/Week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 4

Prerequisites: Linear Algebra, Complex numbers, basics of ZT and FT

Course Objectives:
1. To understand the concept of digital different types of signals and systems.
2. To learn the use of various transforms for different applications.
3. To understand designing steps of various types of digital filters for given applications.

Course Outcomes: the students will be able to:
1. Analyse the signals in time and frequency domain.
2. Apply the transformation tools on signals and systems and analyse their significance and applications.
3. Design the structures of different types of digital filters.
4. Design various digital filters and analyse their frequency response.

Unit 1: Introduction to Signals and Systems (08)

Unit 2: Analysis of Discrete-LTI Systems (07)
Introduction to Convolution, Convolution Sum, Linear and Circular Convolution, Sampling theorem, reconstruction, aliasing, sampling in the frequency domain, sampling of discrete time signals, autocorrelation, cross correlation, decimation and interpolation

Unit 3: Z-Transform, Discrete Fourier Transform and its Properties (08)
Z-transform and its properties, solving difference equations and analysis of discrete-time systems in z-domain, Transfer function, pole-zero plot.
Discrete Fourier Transform (DFT) and its properties, Fast Fourier Transform (FFT), Divide and Conquer Approach, Decimation in Time and Decimation in Frequency FFT Algorithms.

Unit 4: Design of Digital Filters: FIR (07)
FIR Filters: Concept of analog filter design, Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters
Unit 5 : Design of Digital Filters: IIR  
IIR Filters: IIR filter design by approximation of derivatives, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters

Unit 6: DSP Practical Application: 1-D Signal Processing  
Applications of Convolutions, Auto-correlation, Cross-correlations, DFT, Digital filters.  
Biomedical Signal Processing:  
Baseline Wander removal techniques, Power line Interference removal techniques, EMG noise removal techniques, Motion Artifacts removal techniques, Feature extraction like RR interval, Heart rate, Time vs Frequency domain filtering  
Audio Signal Processing: Basics of LPC, MFCC, Introduction to SVD, PCA, ICA, NMF, Spectrogram, Time vs Frequency domain filtering  
Applications of Audio Signal Processing: Audio Equalizer, Noise Filtering, Audio Compression  
Vibration Analysis: Vibration signature analysis for defective gear teeth

Text Books:

Reference Books:

Tutorials:
Minimum 8 assignments based on the course contents
20IN503 Internet of Things

Teaching Scheme:
Lectures: 3 Hrs/week
Tutorial: 1 Hr/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 4

Prerequisites: Basics of sensors and actuators, networks, logic building ability

Course Objectives:
1. To understand building blocks and components of IOT
2. To understand technologies used in IOT
3. To understand the role of platforms and big data in IOT

Course Outcomes: the students will be able to
1. Compare connectivity technologies for IoT.
2. Compare protocols used for IoT applications.
3. Select appropriate IoT technology for given application.
4. Design small system solution for given problem statement.

Unit 1: Introduction to IoT
IoT Basics, Components, architecture, Interdependencies, categories, gateways, associated technologies, Challenges, Considerations, Scalability
Role of sensors, actuators and networks in IoT
Study of Raspberry Pi/ Arduino/ equivalent for integration of sensors/ actuators/ devices in IoT based systems. Small system examples of interfacing sensors and devices to embedded systems for IoT applications

Unit 2: Connectivity Technologies -I
Connectivity technologies: Introduction, Features, working principle, addressing, Routing and applications of Zigbee, IEEE 802.15.4, ZWave, LoRa WAN, Bluetooth and BLE. System examples and case studies using these technologies.

Unit 3: Connectivity Technologies -II
Connectivity technologies: Introduction, Features, working principle, addressing, Routing and applications of GSM, Low Power WiFi, Power Line Communication, RFID, NFC, Sigfox. System examples and case studies using these technologies.

Unit 4: Networking Protocols and Security
Introduction, features, components, methods, variants, communication, Response models, message types, addressing, Routing and applications of 6LoWPAN, MQTT, CoAP, XMPP, AMQP. System examples and case studies using these technologies.
Privacy and Security issue in IoT. Overview of Governance in IoT.
Unit 5: Communication Protocols in Industrial IoT (06)
Introduction, features, components, methods, variants, communication, Response models,
message types, addressing, Routing and applications of Wireless HART, ISA100.11A,
IEEE1451, OPC UA. Case Studies from Home, Infrastructures, Buildings, Industries, Health Care, Inventory Management and Equivalent.

Unit 6: Wireless Sensor Networks and Big Data (06)
Introduction, Features, Components, Multi-hop Paths, Challenges of WSN, Detection and Connectivity, Event Aware Topology Management, Information Theoretic Self-Management of WSN, Applications
Platforms in IoT, Functions, Types, Privacy and Trust in IoT-Data-Platforms for applications
Introduction to Big Data, Cloud Computing, Edge computing and Fog computing
Case Studies from Home, Infrastructures, Buildings, Industries, Health Care, Inventory Management and Equivalent.

Books:
5. “The Internet of Things: Key Applications and Protocols”, by, Wiley

Tutorials:
Minimum 8 assignments based on the course contents
20PEIN501A Modern Control Theory

Teaching Scheme:
Lectures: 3 Hrs/Week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Control Systems

Course Objectives: To
1. Learn basics of Compensator, its types, and Electrical Network.
2. Learn how to Choose and Design a Compensator.
3. Learn PID Control Actions, Requirements, Constraints and Tuning Procedures.
4. Learn and Analyse Controller Design Methods using Modern Control Theory.

Course Outcomes: the students will be able to
1. Investigate system Requirements in Time and Frequency Domain.
2. Compare to classify/choose suitable Compensator.
3. Determine, Controller Tuning Parameters.
4. Apply Modern Control Techniques in Continuous and or Discrete Domain.

Unit 1: Introduction to Modern Control (08)
Introduction to Modern Control Techniques, Classical Control Vs Modern Control, Need to Modern Control Techniques, Advantages and Limitations of Modern Control Techniques, Basic Representation of Modern Control.

Unit 2: Basics of Control Actions and Controller Tuning (06)
Control Actions: ON/OFF, Proportional, Proportional plus Integral, Proportional plus Integral plus Derivative, Controller Tuning Methods.

Unit 3: Controller Design (07)

Unit 4: State Space Analysis (07)
State Transition Matrix, Concept of Controllability and Observability, Controllability and Observability Matrix, Necessary and Sufficient condition for State Controllability and State Observability.

Unit 5: Design Concepts in State Space (08)
Unit 6: Fundamentals of Digital Control

Introduction to Digital Control, Analog Control Vs Digital Control, Need of Digital Control, Advantages of and Limitations of Digital Control, Sample and Hold, Nyquist Theorem, Interpolation and Extrapolation.

Text Books:

Reference Books:
20PEIN501B Biomedical and Analytical Instrumentation

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Human Anatomy and Physiology and Basics of optical Instrumentation.

Course Objectives:
1. To learn functioning of various body organs
2. To study the characteristics of signals generated during the functioning of the organ.
3. To learn bio signal acquisition and measurement techniques
4. To understand laws of photometry
5. To interpret instrumentation required for all types of spectroscopy

Course Outcomes: the students will be able to,
1. Identify the characteristics of bio-signal generated during the functioning of an organ.
2. Analyse the various bio-signals recovered using different biomedical instruments.
3. Interpret instrumentation required for all types of spectroscopy.
4. Apply various principles for analysing different samples using suitable analytical technique.

Unit 1: Cell Anatomy (08)

Unit 2: Cardiovascular System and measurement (08)

Unit 3: Physiological Systems (08)
Respiratory system: lungs anatomy, Regulation of Respiration. Pulmonary function test: lungs volume and capacities, Artificial respiration, Spirometers, ventilators. Structure and function of Neurons, brain anatomy, 10-20 electrode system, EEG basics. Structure and function of Neurons, brain anatomy, 10-20 electrode system, EEG basics, Electroencephalograph. Structure and function of kidneys and Nephron, regulation of water and electrolyte balance, dialysis.

Unit 4: Overview and Introduction of Spectroscopy (06)
Introduction to Analytical methods and its classification, Laws of Photometry, components of
optical systems (source, wavelength selector, detectors, signal processor, readout device), UV-Visible Spectroscopy, IR Spectroscopy.

Unit 5: Absorption & Emission Spectroscopy

Unit 6: Separative Methods & Gas Chromatography
Components of mass spectrometry, Mass analyser types, Quantitative analysis of mixtures Chromatography: Fundamental of chromatographic separation, Gas chromatography, High Performance Liquid Chromatography.

Text Books:
2. Introduction to Biomedical Equipment Technology By Carr & Brown
4. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
6. Medical Instrumentation, John G Webster
20PEIN501C Advanced Microcontroller Techniques

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites:
1. Concepts of Microprocessors and Microcontrollers
2. Logic building concepts and programming microcontrollers in C

Course Objectives:
1. To introduce the architecture and features of high-capacity microcontrollers
2. To provide an understanding of integrated peripherals and its configuration
3. To design system for specified application

Course Outcomes: the students will be able to
1. Select appropriate features of microcontroller for given application.
2. Identify detailed hardware structure and software model of the microcontroller for the given application.
3. Develop configuration of integrated peripherals.
4. Design system for given application using microcontrollers.

Unit 1: Introduction to ARM Cortex (07)
Architecture, Block Diagram, Programmer’s Model, Registers and Memory Management, CPU operating modes, Pipeline, Thumb instructions set, Reset circuit and Sequence. Development Tools, Tool chains, Libraries and Software for programming

Unit 2: The ARM Cortex Processor (08)
Buses, System Timing, Interrupt handling and NVIC, Power management, Clock, comparison with ARM7 and ARM10

Unit 3: Introduction to STM32 microcontrollers (08)
Overview and Features of STM32 Microcontrollers, Advantages, Drawbacks and Subfamilies, Low Power operation and reset sources

Unit 4: Integrated Peripherals of STM32 microcontrollers-I (07)
General Purpose I/O, External Interrupts, ADC and Timers, DMA

Unit 5: Integrated Peripherals of STM32 microcontrollers-II (06)
SPI, I2C, USART, CAN and USB
Unit 6: Small System Design with STM32 microcontrollers

System design for specified applications using integrated peripherals and external components necessary for the same.

Books:
1. Discovering the STM32 Microcontroller, Geoffrey Brown
2. The Insider's Guide To The STM32 ARM Based Microcontroller, Trevor Martin, Published by Hitex (UK) Ltd.
20IN501L Process Loop Components Lab

Teaching Scheme:
Practical: 2Hrs/weeks

Examination Scheme:
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Calibrate various process control components like transmitter, converter etc by selecting proper test and measuring instruments.
2. Find the characteristics of various process control components like transmitter, converter, control valve etc.
3. Configure, tune and test various process control components like pressure switch, transmitter, controller, control valve etc by proper analysis of given application.
4. Develop and implement control circuits and PLC programs for the given application.

List of Practical Assignments: (Minimum 8)
1. Plot the characteristics of the pressure switch and observe the switch output.
2. Testing of various pneumatic and hydraulic components.
3. Identify the sequence of the given Alarm Annunciator and testing of Alarm annunciator using pressure switch
4. Calibration of Temperature Transmitter
5. Calibration of Current to pneumatic Converter
6. Plot the characteristics of square root extractor
7. Calibration of Differential pressure transmitter
8. Calibration of SMART differential pressure transmitter and Flow measurement using SMART differential pressure transmitter
9. Plot the step response of electronic controllers
10. PLC programming
11. Interfacing of PLC to pneumatic circuit
12. Plotting control valve characteristics
13. Open ended assignment on PLC programming

Or similar type of practical assignments based on the course contents
20IN502L Digital Signal Processing Lab

Teaching Scheme:
Practical: 2 Hrs/Week

Examination Scheme:
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Implement various DSP operations like convolution, auto correlation using Matlab.
2. Implement different transforms applied to signals using Matlab.
3. Design and implement IIR and FIR filters for bandpass, band stop, lowpass and high pass filters in Matlab.
4. Develop digital signal processing blocks for given application.

List of Practical Assignments:
Students are expected to perform at least eight experiments using MATLAB or equivalent software:
1. Write a program to generate the basic signals and implement the basic DSP operations on the given signals.
2. Write a Program to implement Linear Convolution of the two given sequences.
3. Write a Program to obtain the auto-correlation and Cross-correlations of the given sequences.
4. Write a Program to obtain the transfer function and plot is pole-zero plot
5. Write a Program to find the DFT of the given sequences. Plot its magnitude and phase plot. Also find its IDFT to obtain the original sequence.
6. Write a Program to design and implement FIR filters using difference windowing methods.
7. Write a Program to design and implement IIR filters (Using Butterworth or Chebyshev approximations).
9. DSP Application: design solution to any application using emerging technologies which is beyond syllabus.

Or similar type of practical assignments based on the course contents
20PEIN501LA Modern Control Theory Lab

Teaching Scheme:
Practical: 2 Hrs/Week

Examination Scheme:
In Semester: 25 marks
Oral: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Compare to Choose suitable Compensator.
2. Choose, Compare suitable Compensator.
3. Determine Controller Tuning Parameters
4. Apply Modern Control Techniques in Continuous and or Continuous/Discrete Domain.

List of Practical Assignments:
1. Effect of Addition of Pole and Zero on Transient and Steady State Performance of System.
2. Design of Lag, Lead-Lag and Lead Compensator.
3. Analysis of Effect of Proportional, Integral and Derivative Control Action.
5. Design of Controller using Direct synthesis Approach for System with and without Dead Time.
6. Computation of State Controllability and State Observability for a System.
8. Computation of Full Order State Observer.

Or similar type of practical assignments based on the course contents
20PEIN501LB Biomedical and Analytical Instrumentation Lab

**Teaching Scheme:**
Practical: 2 Hrs/Week

**Examination Scheme:**
In Semester: 25 marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** the students will be able to
1. Analyse the bio signals acquired by biomedical instruments.
2. Operate biomedical instruments to record bio-signals.
3. Select appropriate analytical instruments for sample analysis based on application.
4. Test samples using various analytical instruments.

**List of Practical Assignments:**
1. To Study principles and design concept of biosensors and their applications in biomedical field.
2. To Measure systolic and diastolic Blood Pressure Using Sphygmomanometer and automatic BP apparatus for different subjects.
3. To study 12 lead configuration and details of ECG waveform using ECG recorder and calculation of heart rate.
4. To study standard amplitude and frequency of EEG signal and to learn frequencies of alpha, beta, delta, theta waves of EEG signal.
5. To learn and record various lung capacities of Respiratory system using Power lab.
6. To Study and Check Specifications of an ECG Recorder. To record various leads of ECG using ECG machine and analysis of recorded ECG signal.
7. To record/monitor first and second heart sound using Electronic Stethoscope and Power lab and analysis of recorded heart sound.
8. To design and implement the photo-plethysmography Sensor for Pulse Rate Measurement.
9. Analysis by using photoelectric colorimeter.
10. Analysis by using Densitometer.
11. Analysis by using Double beam spectrometer.
12. Analysis by using Flame photometer.

Or similar type of practical assignments based on the course contents
20PEIN501LC Advanced Microcontroller Techniques Lab

Teaching Scheme:
Practical: 2 Hrs/Week

Examination Scheme:
In Semester: 25 marks
Oral: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Program microcontroller for given application.
2. Select integrated peripheral for given application.
3. Configure the peripherals in different modes.
4. Debug the developed program / given problem statement.

List of Practical Assignments:
Part A: (any 5)
1. Introduction and familiarization with programming environment of ARM
2. Display interfacing and Programming using ARM
3. Wave generation using ARM
4. Introduction and familiarization with programming environment of STM32
5. Port configuration and programming for input/ output devices
6. Analog input measurement using ADC
7. Communication interface configuration and programming
Part B:
System development using STM32 microcontroller for given problem statement

Or similar type of practical assignments based on the course contents