MKSSS's Cummins College of Engineering for Women, Pune
(An Autonomous Institute Affiliated to SavitribaiPhule Pune University)

Autonomous Program Structure
Third Year B. Tech. Fifth Semester
(Instrumentation and Control)
Academic Year: 2022-2023 Onwards

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral	Practical		
20IN501	Process Loop Components	3	0	0	50	50	0	0	100	3
20IN502	Digital Signal Processing	3	1	0	50	50	0	0	100	4
20IN503	Internet of Things (IoT)	3	1	0	50	50	0	0	100	4
20PEIN501	Programme Elective-I	3	0	0	50	50	0	0	100	3
20PEIN502	Programme Elective-II*	3	0	0	50	50	0	0	100	3
20OEHS501	Open HS Elective –I	3	0	0	50	50	0	0	100	3
20IN501L	Process Loop Components Lab	0	0	2	25	0	0	25	50	1
20IN502L	Digital Signal Processing Lab	0	0	2	25	0	0	25	50	1
20PEIN501L	Programme Elective Lab-I	0	0	2	25	0	25	0	50	1
20AC501	Audit Course	0	0	2	0	0	0	0	0	No Credit
	Total	**18**	**2**	**8**	**375**	**300**	**25**	**50**	**750**	**23**
	Grand Total	**28**			**750**				**750**	**23**

*** NPTEL/Swayam Course**

Department of Instrumentation & Control Engineering

APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

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

Open Elective I (Humanities)

Sr. No.	Course Code	Course Title
1	20OEHS501A	Entrepreneurship Development
2	20OEHS501B	Intellectual Property Rights
3	20OEHS501C	Introduction to Digital Marketing
4	20OEHS501D	Law for Engineers
5	20OEHS501E	Organizational Behaviour
6	20OEHS501F	Project Management

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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:

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 **(08)**

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 **(07)**

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 **(06)**

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:

1. Petruzella, "Industrial Electronics", McGraw-Hill
2. Andrew Parr, "Hydraulics and pneumatics: A Technician's and Engineer's guide",
4. Butterworth Heinemann Ltd
5. C. D. Johnson, "Process control and Instrument technology", Tata McGraw Hill Publications
6. B. G. Liptak, "Process Control", Instrument Engineering Handbook CRC Press.
7. N.A. Anderson, Boca Ratan, "Instrumentation for Process measurement and control" CRC Press, Third ed., 1980.
9. Frank Petruzella, "Programmable Logic Controllers" McGraw-Hill, 2011
10. Gary Dunning, "Introduction to Programmable Logic Controller", Cengage Learning India Pvt. Ltd., Third ed., 2006.

Reference Books:

1. Armando B. Corripio,"Tuning of industrial control systems", ISA.

2. James W. Hutchinson, "Control valve Handbook", ISA
3. E. B. Jones, "Instrument Technology", Butterworth's, Forth ed., 1985
4. William Andrews, "Applied Instrumentation in Process Industries", Gulf, Second ed., 19

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: After the successful completion of the course 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)
Introduction to Signals, Classification of Signals, Continuous Time and Discrete Time Signals, Step and Impulse Functions, Transformation of Independent Variable. Introduction to Systems, Classification of Systems, Properties of Systems, Normal Form of System Equation, Initial Conditions, Impulse Response of a Physical System, system Impulse Response

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 **(06)**

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 **(06)**

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:

1. Nagoor Kani, Digital Signal Processing, Tata McGraw-Hill Education
2. Salivahanan, A Vallaraj, C. Gnanapriya, "Digital Signal Processing", Tata McGraw-Hill Publishing Company Limited.
3. P. Ramesh Babu, "Digital Signal Processing", Sci-Tech Publications
4. S. K. Mitra, "Digital Signal Processing-A Computer Based Approach", MGH

Reference Books:

1. J. G. Proakis and D. J. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", PHI, 2000.
2. V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Pearson Education.
3. Rabiner, Gold, "Theory and Applications of Digital Signal Processing", TMH.
4. E. C. Ifeachor and B. W. Jervis, "Digital Signal Processing-A practical Approach", Addison-Wesley publication

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 **(08)**

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 **(08)**

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 **(07)**

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 (07)

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:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.
2. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.
3. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving".
4. Dieter Uckelmann, Mark Harrison, Florian, "Architecting the Internet of Things", Springer.
5. "The Internet of Things: Key Applications and Protocols", by, Wiley
6. Olivier Hersent, David Boswarthick, Elloumi, Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things", Publisher: Lightning Source Inc; 1st Edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

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: Students will be able to
1. Investigate and Interpret System Requirements in Time and Frequency Domain.
2. Classify, Choose, Compare suitable Compensator.
3. Determine, Compare and Choose 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)**
Design of PI/PD/PID using Root Locus and Bode Plot Approach, Direct Synthesis of Controller, Controller Design for System with and without Dead Time through Controller Synthesis Formula.

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)**

State Variable Feedback, Control System Design using Pole Placement, State Observer, Quadratic Optimal Control System, Design of Optimal State Regulator using Riccati Equation, Concept of Performance Indices.

Unit 6: Fundamentals of Digital Control **(06)**

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:

1. B. C. Kuo, "Digital Control Systems", John Wiley and Sons, 2003.
2. K. Ogata, "Modern Control Engineering", 4th Edition, Pearson Education.
3. D. Roy Choudhury, "Control System Engineering", PHI.

Reference Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., 3rd Edition, 1998.
2. Norman Nise, "Control System Engineering", 3rd Edition, John Wiely and Sons.
3. R.C. Dorf & R.H. Bishop, "Modern Control System", 11th Edition, Pearson Education.
4. Graham C Goodwin, Stefan F. Graebe, Mario E. Salgado, "Control System Design", PHI.
5. Christopher T. Kilian, "Modern Control Technology Components & Systems", 3rd Edition, Cengage Learning.
6. R. T. Stefani, B. Shahian, C. J. Savant and G. H. Hostetter, "Design of Feedback Control Systems", Oxford University Press.
7. Samarjit Ghosh, "Control Systems Theory and Applications", Pearson Education.

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:
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. To interpret instrumentation required for all types of spectroscopy
4. To apply various principles for analysing different samples using suitable analytical technique

Unit 1: Cell Anatomy (08)
Structure and function of Cell. Generation and Conduction of Bio potential, Homeostasis, Sensors: Study of Bio transducers, Biochemical Sensors (Glucose, pH, Po2,Pco2), Electrode as sensor, Types of electrodes, Electrode circuit model.

Unit 2: Cardiovascular System and measurement (08)
Function of heart as Pump, electro conduction system, Basics of ECG, Einthoven triangle, 12 lead Configuration & Electrocardiograph, Types of ECG monitors, Analysis of ECG signal. Correlation of Blood Pressure, Heart Sounds, Blood Flow with ECG, Phonocardiography, Plethysmography Pulse transit time, Pulse wave Velocity, Blood pressure measurement-Manual and Automatic, Blood Flow meters- Electromagnetic, Ultrasound and Dye dilution.

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 (06)

Fluorescence & Phosphorescence Spectroscopy, Atomic absorption spectroscopy: Principle, Hollow cathode source, Types, working, Background correction methods.
Atomic emission spectroscopy: Principle, Sources (AC & DC Arc Excitation, Plasma Excitation), Types, working and Flame photometer.

Unit 6: Separative Methods & Gas Chromatography (06)

Components of mass spectrometry, Mass analyser types, Quantitative analysis of mixtures Chromatography: Fundamental of chromatographic separation, Gas chromatography, High Performance Liquid Chromatography**.**

Text Books:

1. Human Physiology- The Mechanism of Body Function By Vander, Sherman, TMH Ed.1981
2. Introduction to Biomedical Equipment Technology By Carr& Brown
3. Biomedical Instrumentation and Measurements By Cromwell, 2nd edition, Pearson Education.
4. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
5. Text book of clinical Ophthalmology- Ronald Pitts Crick, Pang Khaw, 2nd Edition, World Scientific publication. ISBN 981-238-128-7.
6. Medical Instrumentation, John G Webster
7. Khandpur R. S., Handbook of Analytical Instruments, Tata McGraw–Hill Publications, 3rd ed.
8. Ewing Galen W., Instrumental Methods of Chemical Analysis, McGraw-Hill Book Company, 5th ed.
9. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, CBS Publishers. & Distributors, New Delhi, 7th ed.

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 (06)

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.
3. Mastering STM32, Carmine Noviello, Lean Publishing, 2016
4. The Definitive Guide to ARM Cortex®-M0 and Cortex-M0+ Processors, Joseph Yiu, Second Edition, Elsevier

20PEIN502A Industry 4.0 and IIOT

Teaching Scheme:
Lectures: 3 Hrs/week

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

Prerequisites: Basic knowledge of Computer and Internet

Course Objectives:

1. To understand building blocks, components of IoT and concepts of Industry 4.0
2. To understand technologies used in IoT and Industry 4.0
3. To understand the role of platforms and big data in IoT

Course Outcomes: The students will be able to

1. Identify the different stages of industrial revolution & features of Industry 4.0.
2. Compare connectivity technologies & protocols used for IoT.
3. Comprehend IoT, cyber-physical systems, cloud computing and big data, smart factories and their role in Industry 4.0.
4. Select appropriate IoT technology for an application.

Description:

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle.

Suggested Swayam link:

https://onlinecourses.nptel.ac.in/noc22_cs95/preview

Reference Books:

1. S. Misra, A. Mukherjee, and A. Roy, 2020. *Introduction to IoT*. Cambridge University Press. *Availability:* https://www.amazon.in/Introduction-IoT-Sudip-Misra/dp/1108959741/ref=sr_1_1?dchild=1&keywords=sudip+misra&qid=1627359928&sr=8-1

2. S. Misra, C. Roy, and A. Mukherjee, 2020. *Introduction to Industrial Internet of Things and Industry 4.0.* CRC Press. *Availability:* https://www.amazon.in/dp/1032146753/ref=sr_1_3?dchild=1&keywords=sudip+misra&qid=1627359971&sr=8-3

3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.

4. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.

20PEIN502B Biomedical

Teaching Scheme:
Lectures: 3 Hrs/week

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

Prerequisites: Basics of signals and systems and linear algebra.

Course Objectives:

1. Deduce which imaging technique is appropriate for a given application.
2. Describe their fundamental promises and limitations
3. Differentiate the imaging modalities covered in the course.

Course Outcomes: The students will be able to

1. Delineate various biomedical imaging modalities
2. Differentiate the imaging modalities covered in the course.
3. Select the appropriate imaging technique for given application
4. Identify various medical image processing algorithms

Description:

This course attempts to provide an introduction to the different commonly-used medical imaging systems. Overview of biomedical imaging systems and analysis. Examination of various imaging modalities. Although there are several courses and textbooks available from medical physics background, there are only a few materials that treat the subject from a system's perspective, which is the view point taken here.

Topics: Introduction, 2D- Signals Systems review, Image Quality metrics, Projection Radiography,:X-ray CT, Nuclear Medicine- PET/SPECT, Ultrasound Imaging, MRI

Suggested Swayam link:

https://onlinecourses.nptel.ac.in/noc22_bt56/preview

Reference Books:

1. Medical Imaging Signals and Systems by J. L. Prince and J. M. Links, Pearson Prentice Hall, 2006, ISBN 0130653535.
2. Webb's Physics of Medical Imaging, 2nd Edition, CRC press
3. Foundations of Medical Imaging , Z. H. Cho, J. P. Jones, and M. Singh , Wiley , 1993
4. Stewart C. Bushong, Radiologic Science for Technologists: Physics, Biology, and Protection, 10th ed., Mosby, 2012. (ISBN-13: 978-0323081351)

20IN501L Process Loop Components Lab

Teaching Scheme:
Practical: 2Hrs/weeks

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

Course Outcomes:

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: After the successful completion of the course 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).
8. Generation of signal. Generate a noise signal. Mix both the signals. Design a Filter. Recovery of original signal using filter.
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: Students will be able to
1. Investigate Time and Frequency Domain Specifications.
2. Choose, Compare suitable Compensator.
3. Determine, Compare and Choose 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.
4. Design of P, PI, PID Controller using Frequency Response Approach.
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.
7. Computation of State Feedback Controller using Pole Placement Technique.
8. Computation of Full Order State Observer.
9. Design of Optimal State Regulator for Minimising Performance Index.
10. Formation of a Control System in Discrete Domain.

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:

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.
13. Analysis by using Spectrofluorometer.

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