## Autonomous Program Structure (Modified) of
## Third Year B. Tech. Instrumentation and Control Engineering
## AY: 2019-2020

| T.Y B.Tech. Instrumentation and Control Semester-I | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Course Code | Course Title | Teaching Scheme | | | Examination Scheme | | | | Marks | Credit |
| | | Hours/Week | | | | | | | | |
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Oral | Practical | | |
| IN 3101 | Embedded System Design | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| IN 3102 | Control Systems-II | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| IN 3103 | Control System Components | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| OEHS 3101 | Open Elective- I | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| PEIN 3101 | Programme Elective- I | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| IN 3104 | Embedded System Design Lab | 0 | 0 | 2 | 0 | 0 | 0 | 25 | 25 | 1 |
| IN 3105 | Control Systems-II Lab | 0 | 0 | 2 | 0 | 0 | 0 | 25 | 25 | 1 |
| IN 3106 | Control System Components Lab | 0 | 0 | 2 | 25 | 0 | 0 | 0 | 25 | 1 |
| PEIN 3102 | Programme Elective-I Lab | 0 | 0 | 2 | 0 | 0 | 25 | 0 | 25 | 1 |
| IN 3107 | Lab Practice-II | 0 | 0 | 2 | 25 | 0 | 0 | 0 | 25 | 1 |
| AC 3101 | Audit Course | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | 15 | 2 | 12 | 300 | 250 | 25 | 50 | 625 | 22 |
| Grand Total | | 29 | | | 625 | | | | 625 | 22 |

**OEHS 3101: Open Elective-I**

1. Entrepreneurship Development
2. Introduction to Digital Marketing
3. Intellectual Property Rights
4. Project Management

**PEIN 3101: Programme Elective-I**
**PEIN 3102: Programme Elective-I Laboratory**

1. Optoelectronic Instrumentation
2. Fundamentals of Biomedical Instrumentation
3. Power Electronics and Drives
4. Mechatronics

**AC 3101: Audit Course:** Employability Skills Development

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# IN 3101: Embedded System Design

**Teaching Scheme**
**Lecture: 3 Hr/week**
**Tutorial: 1 Hr/week**

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

**Prerequisites:**
1. Concepts of Digital Electronics
2. Hexadecimal number systems and their arithmetic/ logical operations
3. Basics of C programming

**Course Objectives**:
1. To provide an understanding of hardware and software design and integration for embedded system development
2. To provide the use of on-chip functionalities that can be used in developing embedded systems.
3. To review and develop an embedded system with AVR micro controller.

**Course Outcomes:** The students will be able to
1. decipher the features and on-chip peripherals of AVR micro controller
2. develop niche skills in programming.
3. configure peripherals for a specified application
4. design and develop an embedded systems.

**Unit 1: Introduction to Embedded Systems (AVR ATMega8535)** **(07)**
Overview and Features of AVR ATMega8535, Concepts of Memory (RAM and ROM), Buses, System Clock and Clock Options, Reset Sources, Power Saving Modes

**Unit 2: AVR Architecture and Programming** **(07)**
A. AVR architecture, Instruction Set, Programming techniques for ATMega8535, writing loops and subroutines in assembly and C
B. AVR Port Structure, Alternate Port Functions, I/O configurations

**Unit 3: AVR On chip Timers** **(07)**
B. 8 bit Timer/ Counter 0 with PWM, Modes, Prescaling and Programming
C. 16 bit Timer/ Counter 1, Modes, Prescaling and Programming
D. Watch Dog Timer, concepts, Configuring and Programming

**Unit 4: AVR Interrupts and ADC** **(06)**
A. External and Internal Interrupts, Programming, Configuring and Priority
B. ADC Features, Operation, Programming and Configuring

**Unit 5: On chip serial interfaces: SPI, $I^2C$ and USART** **(07)**
Concepts, Features, Configuration Registers and Programming the AVR for serial interfaces
Introduction to RS232, RS485 and Wireless communication

**Unit 6: AVR based System Development** **(06)**
A. Introduction to Arduino systems
Arduino physical board and libraries and the integrated development environment.
Software libraries and shields for interfacing to the Arduino board. Programming the Arduino.
Introduction to ATMega328P as the processor on Arduino systems
B. Interfacing of external devices

a. LED, Keyboard, LCD display Interfacing to AVR
b. Application examples with Firmware details

**Text Books:**

1. 'The AVR microcontroller and Embedded Systems Using Assembly and C', Mazidi, Naimi, Naimi, Prentice Hall
2. 'Arduino, the complete beginners guide', Bryon Francis
3. 'Embedded Systems, Architecture Programming and Applications', Raj Kamal, McGraw Hill

**Reference Books:**

1. Datasheet of AVR ATMega8535
2. Datasheet of ATMega328P

**List of Tutorials:**

1. Arithmetic and logical operations with Hexadecimal numbers
2. Implementing at least four data transfer instructions using simulator
3. Study the timing details and calculation of time for software delays
4. Study the Stack pointer and Program counter in Branch and Call Instructions
5. Calculation of timer register values for timer 0/1
6. Calculation of timer values for different modes of timer 0/1
7. Calculations for configuration of ADC
8. Understanding configuration registers for interrupts and configuration for the given problem statement
9. Calculation of register values for various baud rates
10. Case study using Arduino system

# IN 3102: Control Systems-II

**Teaching Scheme**
**Lecture: 3 Hr/week**
**Tutorial: 1 Hr/week**

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

**Prerequisite: Control systems–I (IN-2204)**

**Course Objectives:**
1. Apply the basic concepts of control system-I to analyze the system requirements in time and frequency domain.
2. To know the basics of compensator, its types and electrical network.
3. To know how to choose and design the compensator.
4. To learn PID control actions, its requirement, constraints and tuning procedures analytically, numerically and experimentally.
5. To learn design methods of controllers using modern control theory.
6. To analyze the performance of designed controllers.

**Course Outcomes:** The student will be able to
1. investigate and interpret the system requirements both in time and frequency domain.
2. classify, compare and choose the suitable compensator.
3. compare, choose the control structure and determine the controller tuning parameters.
4. apply, analyze and validate the design based on modern control theory.

**Unit 1: Fundamentals of Compensator & Compensator Design by Root Locus Approach (06)**
Need of compensator, types of compensator (series, feedback and feed forward), Types of series compensator (lead, lag, lag-lead) and their transfer functions, Electrical lead, lag and lag- lead compensating networks, lead, lag and lag-lead. Effects of addition of zeros, addition of poles.

**Unit 2: Compensator Design: (08)**
Compensator design using root locus approach. Frequency response of lag, lead and lag-lead compensating networks. Compensator design using Bode plot approach.

**Unit 3: Basics of Control Actions and Controller Tuning (06)**
Control actions: ON/OFF, Proportion, Proportional + Integral, Proportion plus integral plus derivative, Controller tuning methods.

**Unit 4: Controller Design Analytical Approach (06)**
Design of PI/PD/PID using root locus and Bode plot approaches, direct synthesis of controller, controller design for systems with and without dead time through controller synthesis formula.

**Unit 5: Analysis of Control System in State Space (08)**
State transition matrix, concept of controllability: definition, derivation for the necessary and sufficiency condition for complete state controllability, controllability matrix and concept of observability: definition, derivation for the necessary and sufficiency condition for complete state observability, observability matrix.

**Unit 6: Design Concepts in State Space (08)**
State variable feedback, control system design via pole placement, State observer, quadratic optimal control systems, design of optimal state regulator using reduced matrix Riccati equation, concept of performance indices.

**Text books:**

1. B. S. Manke, "Control System Design", Khanna Publishers, New Delhi.
2. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers.

**Reference books:**

1. K. Ogata, "Modern Control Engineering", PHI, New Delhi.
2. Norman S. Nise, "Control System Engineering", John Wiley and Sons.
3. B. C. Kuo, "Automatic Control Systems", PHI New Delhi.
4. Graham C. Goodwin, Stefan F. Graebe and M. E. Salgado, "Control System Design", PHI, New Delhi.

**List of Tutorials:**

1. Effect of addition of poles and zeros on system's transient and steady state performance.
2. Mathematical modeling of electrical lag, lead and lag-lead compensator.
3. Analysis of effect of proportional, Integral and derivate control actions.
4. Design of PI, PD and PID controllers using root locus and frequency response approach.
5. Design of controller using direct synthesis approach for system with and without dead time.
6. Computing complete state controllability and complete state observability for given system.
7. Computation of State feedback controller via pole placement.
8. Computation of full order state observer.
9. Design of optimal state regulator for minimizing given performance index using reduced matrix Riccati equation.

# IN 3103: Control System Components

**Teaching Scheme**
**Lecture: 3 Hr/week**

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

**Prerequisites**: Sensors and transducers, pneumatic flapper nozzle system

**Course Objectives**:
1. To select different electrical control system components like AC motor, relays, switches and develop sequencing and interlocking circuits
2. To analyse the working of electrical, hydraulic, pneumatic components and auxiliary components
3. To develop pneumatic circuits for given application using various pneumatic components
4. To develop hydraulic circuits for given application using various hydraulic components

**Course Outcomes**: The student will be able to
1. delineate working of different types of ac motors, electrical, pneumatic and hydraulic components
2. compare and analyse the working of different types of ac motors, electrical, pneumatic and hydraulic components and systems
3. select electrical, hydraulic and pneumatic components to solve a given problem
4. develop various electrical wiring diagram and hydraulic, pneumatic circuits for the given application

**Unit 1: AC Motors** **(08)**
Comparison of electrical systems and other systems. Types, construction, working, characteristics, applications of single phase motors and three phase induction motor. Need of starters, types of starters, Direction reversal, speed control methods

**Unit 2: Special Purpose Motors** **(04)**
Types, construction, working, characteristics, applications of special purpose motors like stepper motor and servomotors. AC and DC position and speed control. Synchros for error detector, position measurement and control.

**Unit 3: Industrial Devices** **(06)**
Types, construction, working, application, and symbolic representation of switches (toggle switch, slide switch, DIP switch, rotary switch, thumbwheel switch, selector switch, push button, limit switch, Drum switch, process switches), relays (EMR, Reed relay, Solid state relays), and contactors. Specifications/selection criteria and applications. Comparison between relay & contactor.

**Unit 4: Motor Control Circuits** **(06)**
Concept of sequencing & Interlocking. Standard symbols used for Electrical Wiring Diagram, Electrical wiring diagram in relation to motors for Starting, Stopping, Emergency shutdown starters. Motor protection circuits (short circuit protection, over load protection, low/under voltage protection, phase reversal protection, over temperature protection). Circuits for reversing direction of rotation, braking, starting with variable speeds. ,jogging/Inching. Motor control center: concept and wiring diagrams.

**Unit 5: Pneumatics** **(08)**

Comparison of pneumatic systems and other systems. Pneumatic supply, pneumatic components like pneumatic relay, Actuators (Single acting & double acting cylinder , special cylinders, air motors), Filter Regulator Lubricator (FRL), pneumatic valves (direction controlled valves, flow control etc) , special types of valves like relief valve, pressure reducing etc. ,time delay valve. Standard Symbols used for developing pneumatic circuits ,sequence diagram (step-displacement) for implementing pneumatic circuits, different pneumatic circuits(reciprocating, sequencing, anti-cycle repetition, block transfer, speed regulation etc)

**Unit 6: Hydraulics and Auxiliary Components** **(08)**

Comparison of hydraulic systems with other systems. Hydraulic supply, hydraulic pumps, hydraulic components actuator (cylinder & motor) and hydraulic valves. Standard symbols for developing hydraulic circuits. Different Hydraulic Circuits (Meter in, Meter out, Reciprocating, speed control, sequencing of cylinders, direction control etc). Construction, working & applications of: auxiliary components like Alarm annunciator, High/low selectors, Flow totalizer, Computing relays, Seals, Snubber, Circuit Breaker

**Text Books:**

1. B. L. Theraja, "Electrical Technology", S. Chand and Company.
2. Petruzella, "Industrial Electronics", McGraw-Hill
3. Majumdhar, "Pneumatic Instrumentation", TMH
4. Andrew Parr, "Hydraulics and pneumatics : A Technician's and Engineer's guide", Butterworth Heinemann Ltd
5. B.G. Liptak, "Process Control, Instrument Engineering Hand book", Butterworth-Heinemann Ltd

**Reference Books:**

1. Pneumatics, Festo Didactic
2. Hydraulics, Festo Didactic

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# PEIN 3101 (A): Optoelectronic Instrumentation

**Teaching Scheme**
**Lecture: 3 Hr/week**

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

**Prerequisites:** Fundamentals of light

**Course Objectives:**
1. To study various optical sources, detectors and components
2. To understand the basics of LASER and its types
3. To learn basics of Fiber Optics and types of Fiber Optic cables

**Course Outcomes:** The student will be able to
1. select suitable optical components for various applications.
2. compare and analyze types of LASER and fiber optic cables.
3. select suitable type of LASER and/ or fiber optic cable for different applications.
4. design an optical measurement system for the required application.

**Unit 1: Optical Sources and Detectors** **(07)**
Electromagnetic spectrum, Photometry and Radiometry, LED – construction, working and structures, quantum detectors - CCD device, photo-diode; GOD-POD and Hexakinese methods for Blood Glucose estimation

**Unit 2: Optical Components** **(08)**
Gratings [Diffraction grating and its types], Lenses, Polarizer [Linear- Absorptive, beam splitting; Circular] – working principle and overview of its types, Beam Splitter, OTDR, Power meter
Basic principles of Holography, hologram

**Unit 3: LASER Basics** **(07)**
Basic properties of LASER light, single mode operation, stabilization, mode locking, Q-switching, Applications of LASER

**Unit 4: Types of LASER** **(08)**
Semiconductor, Gas – He, Ne, Krypton; Chemical, Solid state – Ruby, NdYAG; Tunable Laser

**Unit 5: Fiber Optics** **(06)**
Plane, circularly and elliptical polarized light, Brewster angle, Total Internal Reflection, losses in optical fiber – bend loss, splice loss, attenuation, Applications of Fiber Optics

**Unit 6: Fiber Optic Cables and Sensors** **(06)**
Fiber Optic cables - Simplex, Duplex, Fibre optic ribbon, loose tube, Distribution, Break-out; Extrinsic and Intrinsic Fiber Optic Sensors

**Text Books:**
1. J. Wilson, Optoelectronics, Prentice-Hall of India
2. Amar Ganguly, Optics and Optoelectronics, Narosa Publications, New Delhi
3. John M. Senior, Optical Fiber Communications, Prentice Hall of India,3rd edition

**Reference Books:**
1. Silvano Donati, Electro-Optical Instrumentation, Pearson Education, Inc.,2004
2. Optical Fiber Sensors, John Dakin and Brian Culshaw, Artech house, 1997

# PEIN 3101 (B): Fundamentals of Biomedical Instrumentation

**Teaching Scheme**
**Lecture: 3 Hr/week**

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

**Prerequisites:** Human Anatomy and Physiology

**Course Objectives:**

1. To know functioning of various body organs
2. To understand the characteristics of signals generated during the functioning of the organ.
3. To learn bio signal acquisition and measurement techniques
4. To study safety aspects of biomedical instruments

**Course Outcomes:** The student will be able to

1. identify various anatomical structures and state their functioning.
2. compare and select sensor for capturing the physiological signals.
3. use of biomedical instruments to record and analyze bio signals.
4. implement safety aspects during product designing.

**Unit 1: Cell Anatomy** **(08)**

Structure and function of Cell, Nernst and Goldman equation. Generation and Conduction of Bio-potential, Homeostasis, Sensors: Study of Bio transducers, Biochemical Sensors (Glucose, pH, $Po_2$, $Pco_2$), Electrode as sensor, Types of electrodes, Electrode circuit model

**Unit 2: Cardiovascular System** **(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

**Unit 3: Cardiovascular Measurement and Musculo-Skeletal System** **(08)**

Phonocardiography, Plethysmography Pulse transit time, Pulse wave Velocity, Blood pressure measurement- Manual and Automatic, Blood Flow meters- Electromagnetic, Ultrasound and Dye dilution

Structure of Skeletal Muscle, Types of Muscles, EMG Signal, Electromyography

**Unit 4: Nervous and Sensory System** **(06)**

Structure and function of Neurons, brain anatomy, 10-20 electrode system, EEG basics, Electroencephalography, EEG Analysis

Sensory Organs: Structure and function of Eye, Ear- Mechanism of Hearing, Auditory pathway

Special sensors: tongue-test, nose-smell, skin-touch, temperature regulation

**Unit 5: Urinary and Respiratory System** **(04)**

Structure and function of kidneys and Nephron, Mechanism of Urine formation, regulation of water and electrolyte balance.

Respiratory system: lungs anatomy, Regulation of Respiration. Pulmonary function test: lungs volume and capacities, Artificial respiration

**Unit 6: Bioelectric Signal Conditioning Techniques** **(06)**

S/N Ratio, Filters like Notch, Band pass, Instrumentation Amplifier, Isolation Amplifier, Transient Protection, Electrical Safety: Significance of Electrical Danger, Physiological Effect of Current, Micro-shock and Macro-shock.

**Text Books:**

1. Introduction to Biomedical Equipment Technology by Carr & Brown
2. Biomedical Instrumentation and Measurements by Cromwell, 2nd edition, Pearson Education.
3. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
4. Biomedical Instrumentation, Arumugam
5. Text book of clinical Ophthalmology- Ronald Pitts Crick, Pang Khaw, 2nd Edition, World Scientific publication. ISBN 981-238-128-7
6. Biomedical Instrumentation and measurement, R. Anandanatarajan

**Reference Books:**

1. Human Physiology- The Mechanism of Body Function by Vander, Sherman, TMH Ed.1981
2. Medical Instrumentation, John G Webster

# PEIN 3101 (C): Power Electronics and Drives

**Teaching Scheme**
**Lecture: 3 Hr/week**

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

**Prerequisites:** Linear Integrated Circuits and Digital Electronics

**Course Objectives**:

1. To understand and analyze different power electronic devices.
2. To study of different special purpose integrated circuits.
3. To use different control methodologies based on different applications.
4. To use the knowledge to understand and solve practical problems.

**Course Outcomes:** The student will be able to

1. list and define characteristics of different power devices.
2. compare and select various power circuits and motors for suitable applications.
3. develop controlling circuits for various design stages.
4. design and construct the suitable controlling circuit for given applications.

**Unit 1: Introduction to Power Devices** **(07)**

Construction, Working, Characteristics, Specifications and applications of SCR, TRIAC, DIAC, Power MOSFET, and UJT, SCR gate triggering and commutation circuits , Series and Parallel connection of SCR and its triggering arrangement

**Unit 2: Converters** **(06)**

**Converters:** Single Phase and Three Phase controlled rectifiers, (Half wave, full wave and bridge Configuration) with resistive and inductive load with freewheeling diode.

**Unit 3: Choppers and Inverters** **(08)**

**Choppers:** Principle, Working, Classification, Thyristor choppers- Jones Chopper, Morgan Chopper, Chopper controlling strategies.
**Inverters:** Classification, Single Phase half bridge and full bridge Inverters, PWM Inverters
**Uninterrupted Power Supply (UPS)**: Principle, Construction, Working, Types, Application

**Unit 4: DC Motors** **(07)**

Principle, Construction, Working, Types, Characteristics and Applications of DC Motors, Permanent-Magnet DC Motors (PMDC), Position Servo, Miniature DC Motors, Brushless DC Motor, Drivers for DC Motor

**Unit 5: Stepper Motors** **(08)**

Principle, Construction, Working, Types, Characteristics and Applications of Stepper motors, L298 H-Bridge Drive, L297 Stepper motor sequencer and drive, Half step and Full step method of stepper motor drive, Chopper drive, Speed and direction control

**Unit 6: Controllers for AC Loads** **(04)**

Solid state relays, Firing angle control, AC Synchronous motor drive, Variable frequency drive (VFD), Controllers for Lamps, Heaters

**Text Books:**

1. M.D. Singh, K. B. Khanchandani, 'Power Electronics', 2ndedition, McGraw Hill Company
2. B. L. Theraja and A. K. Theraja, S. Chand &Sons, "A textbook of Electrical Technology", Volume-II, AC & DC Machines

**Reference Books:**

1. P. C. Sen,' Power Electronics ', TMH, 2007
2. Mohamad Rashid,' Power Electronics', PHI, 2ndedition, 2004
3. G.K.Dubey, Power semiconductor controlled drives, Prentice Hall- 1989
4. Bhag S. Guru, Huseyin P. Hiziroglu,"Electric Machinery and Transformers", Third Edition, Oxford University Press
5. Krishnan, Electrical Motor Drives, PHI-2003

# PEIN 3101 (D): Mechatronics

**Teaching Scheme**
**Lecture: 3 Hr/week**

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

**Prerequisites:** Basic Electronics, Basic Mechanical Engineering

**Course Objectives:**

1. To discuss the concepts and key elements of Mechatronics system.
2. To explain principles and characteristics of Sensors and Transducers.
3. To describe working principle of Hydraulic and Pneumatic systems and applications.
4. To give examples of applications of Mechatronics Systems.

**Course Outcomes:** The students will be able to

1. Identify key elements of Mechatronics System and its representation in terms of block diagram.
2. Classify sensors and transducers according to their applications.
3. Design signal conditioning circuits for given sensors/transducers.
4. Explain working principle and applications of Hydraulic and Pneumatic systems.
5. Interface Hydraulic/Pneumatic system components for given task.
6. Discuss role of Mechatronics Systems in Modern Automation.

**Unit 1: Elements of Mechatronics Systems** **(06)**

Introduction to Mechatronics, key element/components, level of Mechatronics system design, phases of Mechatronics design process, integrated design approach, Advantages, and disadvantages of Mechatronics systems, Mechanical components: cam, gears, gear-train, servomechanism, and its application

**Unit 2: Sensors and transducers** **(10)**

Overview of Sensors and Transducers, classification, and their Characteristics. Temperature: Thermistor, RTD, semiconductor (AD590, LM35, LM75), IR sensor, Force: strain gauge, Load Cell, Pressure: Strain gauge, Piezoelectric, Displacement/Position: potentiometer, LVDT, proximity, optical encoder, Ultrasonic transducer, Level and Flow: ultrasonic transducer, Vibration and acceleration: piezoelectric accelerometer

**Unit 3: Signal conditioning and Data Acquisition Systems** **(06)**

Signal conditioning: its necessity, Amplification, filtering and Impedance Matching, protection, 4-20 mA Transmitters, Data Acquisition system: its necessity, components of DAQ, data conversion, and data signal transmission and its representation.

**Unit 4: Hydraulic and Pneumatic Actuating System** **(08)**

Introduction to Hydraulic Actuating system, Physical Components of Hydraulic systems, types of Hydraulic actuators and their applications. Introduction to Pneumatic Actuators systems, Physical Components of a Pneumatic Systems, types of Pneumatic Actuators/Cylinders and its applications. Comparison of hydraulic and pneumatic actuators. Valves: Pressure relief, Pressure regulator and directional Control Valve (3/2 Valves, 4/2 Valves, 5/3 Valves)

**Unit 5: Introduction to Electrical Actuators and Electro-Mechanical Actuators (06)**

Selection criteria and specifications of stepper motors, servomotors, solenoid valves, Solid State relays and Electromechanical relays. Electro-Pneumatic: Physical Components of Electro-Pneumatic systems.

**Unit 6: Mechatronics Systems Applications (06)**

Mechatronics Systems in Automobile, Engine Management systems, Antilock Brake systems (ABS), washing machine, pick and place robot, introduction to CNC Machines.

**Text Books:**


1. Bolton W., "Mechatronics Electronic systems in Mechanical and Electrical engineering", *Pearson Education*, (6th Edition), (2016).
2. K.P.Ramachandran, G.K.Vijayaraghavan and M.S. Balasundaram, "Mechatronics-Integrated Mechanical Electronic Systems", *Wiley Publication*, (1st Edition), (2008).
3. David Alciatore and MaichaelB Histand, "Introduction to Mechatronics and Measurement Systems", *Tata McGraw Hill*, (4th Edition), ( 2013).


**Reference Books:**


1. Doeblin E.O., "Measurement System-Application and Design", *TMH, New Delhi*, (4th Edition), (2004)
2. Mahalik N. P., "Mechatronics - Principles, Concepts and Applications", *TMH, New Delhi*, (2th Edition), (2014)
3. Devdas Shetty and Richard A.Kolk, "Mechatronics System Design", *Thomson India Edition*, (1st Edition), (2007).


Online Recources:

1. http://nptel.ac.in/courses/112103174/

# IN 3104: Embedded System Design lab

**Teaching Scheme**
**Practical: 2 Hr/week**

**Examination Scheme**
**Practical: 25 Marks**
**Credit: 1**

**Course Outcomes:** The student will be able to
1. exemplify the different instructions of the micro controller
2. implement loops, subroutines using programming skills
3. select appropriate peripheral for given application
4. differentiate between the modes and configurations of on chip peripherals

**List of Experiments: (any 8)**

1. Introduction and familiarization with programming environment of AVR
2. Arithmetic and Logical Operations in AVR
3. Accessing memory and exchanging data within memory addresses
4. Introduction to C programming and sorting of numbers in C
5. Square wave generation using software delay
6. Square wave generation using hardware delays, with polling and interrupts
7. Frequency counter
8. Interfacing of LCD display
9. Introduction to Arduino system Programming
10. Interfacing LED to Arduino System

# IN 3105: Control Systems-II Lab

**Teaching Scheme**
**Practical: 2 Hr/week**

**Examination Scheme**
**Practical: 25 Marks**
**Credit: 1**

**Course Outcomes:** The student will be able to
1. investigate and interpret the system requirements both in time and frequency domain.
2. design the compensator in time and frequency domain
3. design, compare, choose the control structure and determine the controller tuning parameters.
4. apply the concepts of modern control theory for the analysis of system requirements and controller design

**List of Experiments:**
1. Introduction to soft computing tools for design and analysis of compensator/controllers.
2. Design and performance analysis of lead / lag compensator using root locus approach.
3. Design and performance analysis of lead / lag compensator using Bode plot approach.
4. Tuning (Ziegler-Nicholas closed loop method) and performance analysis of P, PI and PID controllers for given plant transfer function.
5. Tuning (Ziegler-Nicholas and Cohen-Coon open loop method) and performance analysis of P, PI and PID controllers for given plant transfer function.
6. Simulation and performance analysis of a state feedback controller.
7. Simulation and performance analysis of full order state observer.
8. Case study of design, simulation and Real-time implementation of controller.

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# IN 3106: Control System Components Lab

**Teaching Scheme**
**Practical: 2 Hr/week**

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

**Course Outcomes:** The student will be able to

1. characterize performance of motors and various electrical, hydraulic, pneumatic components.
2. select electrical, hydraulic and pneumatic components to solve a given problem.
3. develop various electrical wiring diagram and hydraulic, pneumatic circuits for the given application by proper analysis.
4. implement electrical and hydraulic, pneumatic circuits for given application.

**List of Experiments:**

Students are expected to perform Minimum 8 Experiments:

1. Characteristics of motor
2. Study of stepper motor
3. Implementation of logic gates using relays.
4. Protection/sequencing and interlocking circuits for motor
5. Study of various pneumatic and hydraulic power supplies.
6. Study of various pneumatic and hydraulic components
7. Implementation and testing of pneumatic circuits.
8. Implementation and testing of hydraulic circuits.
9. Study of Synchro transmitter and receiver system.
10. Study of Pressure/temperature/level/flow switches.
11. Demonstration & study of auxiliary components like alarm annunciation.

# PEIN 3102 (A): Optoelectronic Instrumentation Lab

**Teaching Scheme**
**Practical: 2 Hr/week**

**Examination Scheme**
**Oral: 25 Marks**
**Credit: 1**

**Course Outcomes:** The student will be able to

1. compare and select appropriate optical component for the defined application.
2. identify various optical instruments required for measurement of various optical parameters.
3. interpret the characteristics of different LASER sources
4. test the specifications of the given optical fiber

**List of Experiments:**

1. Study of various types of optical sources – halogen, incandescent, sodium vapour
2. To obtain current-intensity plots of different red, green and blue LEDs
3. Study of working of polarizer and lenses with different sources
4. To plot the line spectra of Neon lamp using a monochromator
5. Measurement of current-intensity relationship of Laser diode
6. Study of working of any 2 types of LASER
7. To study the optical characteristics of an optical fibre using OTDR
8. To measure optical power of source using power-meter

# PEIN 3102 (B): Fundamentals of Biomedical Instrumentation Lab

**Teaching Scheme**
**Practical: 2 Hr/week**

**Examination Scheme**
**Oral: 25 Marks**
**Credit: 1**

**Course Outcomes:** The student will be able to

1. use biomedical instruments to record and analyze bio-signals.
2. demonstrate working of various biomedical instruments.
3. design and implement various signal conditioning circuits for bio signal processing
4. use modern hardware and software tools for biosignal acquisition and analysis.

**List of Experiments:**

Students are expected to perform minimum 8 experiments:

1. To study principles and design concept of bio transducers 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 calculate 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 structure and function of various parts of kidney.
7. Study of anatomy and function of each part of eye and ear (Sensory Organ).
8. To design a Notch Reject Filter for Power Line Frequency. To record the frequency response of notch filter.
9. To design and implement an Instrumentation/ ECG Amplifier for displaying ECG on DSO.
10. To design and implement an analog and digital Heart Rate Meter to measure the Heart rate.
11. To study and check specifications of an ECG Recorder.
12. To record heart sounds and ECG using Power lab and study correlation of ECG and PCG.
13. To monitor plethysmograph sensor output using Power lab and calculate pulse rate.
14. To design and implement the photo-plethysmography Sensor for Pulse Rate Measurement.

# PEIN 3102 (C): Power Electronics and Drives Lab

**Teaching Scheme**
**Practical: 2 Hr/week**

**Examination Scheme**
**Oral: 25 Marks**
**Credit: 1**

**Course Outcomes:** The student will be able to

1. find characteristics of different power devices.
2. select and develop control circuits using power devices for the given application.
3. design the circuits for control of various motors.
4. implement and test the designed control circuit for various applications.

**List of Experiments:** (Eight experiments from the following list)

1. UJT Relaxation oscillator.
2. SCR characteristics.
3. Triac characteristics.
4. Single phase half wave controlled Rectifiers.
5. Single phase fully controlled Rectifiers.
6. Study of DC to DC converter
7. Design and testing of PWM controller for miniature servo
8. D.C. motor control using L293
9. Stepper motor control using L298 and sequencer
10. A.C. load control using Solid state relay

# PEIN 3102 (D): Mechatronics Lab

**Teaching Scheme**
**Practical: 2 Hr/week**

**Examination Scheme**
**Oral: 25 Marks**
**Credit: 1**

**Course Outcomes:** The student will be able to,

1. measure load, velocity, flow and level using analog and digital sensors.
2. interface sensors with data acquisition system and monitor data trending.
3. interface components of electro-hydraulic or electro-pneumatic and hydraulic or pneumatic to build circuits.
4. develop and demonstrate application of Mechatronics system using suitable hardware.

**List of Experiments:**

1. Weight measurement using Load cell.
2. Velocity measurement using Optical Encoder.
3. Liquid flow measurement using Turbine flow sensor.
4. Liquid level measurement using Capacitance sensor.
5. Interfacing any two sensor with Data Acquisition System and observe data trending.
6. Interface Hydraulic System Component to actuate single acting and double acting actuators.
7. Interface electro-hydraulic system components to actuate single acting and double acting actuators.
8. Interface pneumatic system components to actuate single acting and double acting actuators.
9. Interface electro- pneumatic system components to actuate single acting and double acting actuators.
10. Design and Implement Mechatronics system for any application.

# IN 3107 Lab Practice-II

**Teaching Scheme**
**Practical: 2 Hr/week**

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

**Prerequisite: C/C++/MatLab/Octave/SciLab**

**Course Objectives:**
1. Apply the knowledge of C/C++/Matlab to solve the numerical methods.
2. To understand fundamental methods required for scientific data analysis.

**Course Outcomes:** The student will be able to
1. solve non linear and differential equation using modern computer languages.
2. apply numerical integration methods to solve problems
3. apply numerical differentiation methods to solve problems
4. able to develop the algorithm to implement mathematical solutions of any engineering problem.

**Write and execute a program using C/C++/MatLab with algorithm and flow chart.**
1. To find the roots of nonlinear equation using Bisection method & Newton's method.
2. To fit the curve by least square approximation.
3. To solve the system of linear equations using Gauss Elimination method.
4. To integrate numerically using Trapezoidal rule.
5. To Integrate numerically using Simpson's rules.
6. To find numerical solution of ordinary differential equations by Euler's method.
7. To find numerical solution of ordinary differential equations by Runge Kutta Method
8. To find the largest Eigen value of a matrix by power method.

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MKSSS's Cummins College of Engineering for Women Karvenagar, Pune-411052

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MKSSS's Cummins College of Engg. For Women, Karvenagar, Pune-52.

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