Semester-VI

PC-IC 601	**Process control**	**3L:0T:0P**	**3 credits**

Course outcome:

1. To introduce the terminology, concepts and practices in process modeling and automatic process control.
2. To impart knowledge in the design of control systems and PID controller tuning for processes.
3. To impart knowledge in concepts of advanced process control.
4. To impart knowledge in Programmable logic controller(PLC)

Module 1: Introduction to Process Control System: (10 hours)

Process control System Terms and objectives, piping and Instrumentation diagram, instrument terms and symbols. Regulatory and servo control, classification of variables.

Process characteristics: Process equation, degrees of freedom, modeling of simple system, Self-regulating processes, interacting and non- interacting processes, Process lag, load disturbance and their effect on processes.

Process modeling: Process equations-their limitations-general approach, typical processes and derivation of their functions.

Module 2: Different Controller modes and its tuning (12 hours)

Basic control action, two position, multi-position, floating control modes.

Continuous controller modes: proportional, integral, derivative. Composite controller modes: P-I, PD, P-I-D, Integral wind-up and prevention. Auto/Manual transfer, Bumpless transfer. Response of controllers for different test inputs. Selection of control modes for processes like level, pressure, temperature and flow.

Controller tuning Methods: Evaluation criteria - IAE, ISE, ITAE. Process reaction curve method, continuous oscillation method, damped oscillation method. Auto tuning. Closed loop response of I & II order systems, with and without valve, measuring element dynamics.

Module 3: Advanced process control schemes: (7 hours)

Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, interaction of control loops. Smith predictor, internal model control.

Module 3: Final control elements: (6 hours)

Pneumatic and electrical actuators, Valve positioners. Pneumatic and electrical dampers, Control valves types, construction details, various plug characteristics. Energy efficient valves - Valve sizing - selection of control valves. Inherent and installed valve characteristics. Fail-safe operation, Cavitation and flashing in control valves, Instrument air supply specifications.

Module 4: Introduction to PLC (5 hours)

Basic Architecture and function, Input-output modules and interfacing, CPU and memory, Relays, Timers, Counters and their uses, PLC programming and applications, Introduction to DCS.

Text Books:

1. D.C. Sikdar, Instrumentation and Process Control, Khanna Publishing House (2018)

2. G.Stephanopoulos, Chemical Process Control-An Introduction to Theory and Practice Prentice Hall of India, New Delhi, 3rd Edition, 2008.

3. D.R. Coughanowr, Steven E LeBlanc, Process Systems Analysis and Control, McGraw Hill, Singapore, 3rd Edition, 2009.
4. B.W. Bequette, Process Control Modeling, Design and Simulation, Prentice Hall of India, New Delhi, 2004.

Reference Books:

1. C.A.Smith and A.B Corripio., Principles and Practice of Automatic Process Control, John Wiley and Sons, New York, 3rd Edition 2005.
2. Paul W.Murril, Fundamentals of Process Control Theory, ISA press, New York, 3rd Edition,2000.
3. Bela G. Liptak, Instrument Engineers' Handbook, Volume II: Process Control and Optimization, CRC Press, 4th Edition, 2005.

PC-IC602	**Data Communication and Telemetry**	**3L:0T:0P**	**3 credits**

COURSE OUTCOME

At the end of this course, the incumbent will be able to:

- To acquire knowledge about the basics of Linear Modulation , classification,their spectra and circuitry for generation and demodulation.
- Ability to identify, analyze & design Pulse analog Modulation with circuitry.

- Ability to understand the FDM and TDM technique and comparision study between them.
- Describe about the basics and various types of telemetry system.
- To acquire knowledge about the fundamentals of data communication systems and its protocols**.**
- To acquire knowledge about the digital modulation tecnnique.

Detailed contents:
Module 1: (8 lectures)
Linear Modulation:

Introduction , Amplitude Modulation (AM) , modulators and demodulators, power in AM wave , spectrum of AM wave , DSB/SC, SSB and VSB signals, their spectra and circuitry for generation and demodulation. Phase modulation.

Module 2: (8 lectures)
Pulse analog modulation:

Practical aspects of sampling, reconstruction of a message process from its samples, Time Division Multiplexing (TDM), comparison of TDM and FDM , Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), circuitry for generation and recovery. Pulse digital modulation: Pulse Code Modulation (PCM), noise PCM system, Differential Pulse Code Modulation (DPCM), Delta Modulation (DM), Digital multiplexers, T1 System.

Module 3: (8 lectures)

Telemetry :

Fundamentals of telemetry, signal conditioning, FDM / FM telemetry, PAM, PWM telemetry systems. Multiplexing,decommutation, PCM telemetry systems. Signal generations, bit word and frame synchronization. Power line carrier communication. Spread spectrum techniques. and wait, go back N and selective repeat request protocols.

Module 4: (8 lectures)
Introduction to data communication:
Data transfer modes, parallel I/O and serial I/O, asynchronous and synchronous data transfer schemes, USART for data transfer, interface standards for serial I/O and parallel I/O, protocols for synchronous communication ,BISYNC and HDLC, stop and wait, go back N and selective repeat request protocols.

Module 5: (8 lectures)
Digital Modulation Techniques:
Introduction, ASK, ASK Modulator, Coherent ASK Detector, Non-Coherent ASK Detector, FSK, Bandwidth and Frequency Spectrum of FSK, Non Coherent FSK Detector, Coherent FSK Detector, FSK Detection using PLL,
BPSK, Coherent PSK Detection, QPSK, 8-PSK, 16-PSK Differential PSK,QAM.

RECOMMENDED READINGS

TEXT

1. Communication Systems, A. Carison Bruce, Third edition,McGrawHill,New York 1987.
2. Telecommunication and Switching systems and Networks, T .ViswanathanPrentic Hall, New Delhi, 1992
3. Telemetry Principles, D. Patranabis, Tata McGraw Hill, New Delhi, 1999.

REFERENCE
1. Principles of Communication Systems, Taub& Schilling ,Tata Mcgraw Hill, New Delhi, 1991.
2. Microprocessors and Interfacing, Dauglas Hall, fourth edition, Tata McGraw Hill,1990.
3. Tele control Methods and Applications of Telemetry and Remote Control, G. Swoboda , Reinhold Publishing Corp., London, 1991.

PC-IC603	**Biomedical Instrumentation**	**3L:0T:0P**	**3 credits**

Module	Content	Hour
1	**Fundamentals:** Introduction to Physiological Systems –Organism, Cardiovascular, Respiratory, Renal, Hepatic, Gastrointestinal, Endocrinal, Nervous, Muscular, Cellular. Biological Signals – Bioelectric events, Biomechanical Systems, Cellular & Membrane phenomenon. The Action Potential and Propagation through Nervous System. The Peripheral Nervous Systems and sensory mechanisms. Biomaterials. Fundamentals of Electrophysiology –EKG, EEG, EMG, Evoked potentials. Quantification of Biological Signals.	08
2	**Measurement & Analysis:** Biological Sensors- Bio-electrodes, Biosensors and Transducers for Cardiology, Neurology, Pulmonary, Oxygen saturation & gaseous exchange, flow measurement, goniometry, Endoscopy, Impedance Plethysmography. Biological Amplifiers –Instrumentation Amplifiers f or Electrophysiology (ECG, EMG, EEG, EOG), Filters, Power Supplies.	10

	Recording and Display systems, Digital Conversion for storage, Electrical Hazards in measurements, Isolation Circuits, calibration, alarms & Multi-channel re-constitution. Hospital requirements – Multi-parameter bed-side monitors, Central Nursing Stations, Defibrillators, Ventilators, Catheters, Incubators.	
3	**Life-Support & Treatment:** Cardiac Support: Implantable & programmable Pacemakers, External & Internal	
	Defibrillators, Coronary Angiography. Electro-physiotherapy: Shortwave & ultrasonic diathermy, Transcutaneous. Nerve Stimulators in pain relief, Traction Systems, Ultrasound in bone fracture regeneration, hypothermia & hyperthermia systems. Lasers in treatment and surgery :Opthalmic, Ablators, Endoscopic. Assists and Artificial limbs- Orthoses , passive and powered Prostheses	10
4	**Imaging:** Fundamentals of X-Rays, Radiological Imaging, Digital Radiology, DSA. Computer Tomography, Image Processing, solid state sensors, whole-body scans. Gamma camera & radio- isotope imaging. Ultrasonography- Transducers, Signal Conditioners, 2D & 3D scans, Doppler &Colour Doppler. Fundamentals of Magnetic Resonance Imaging and PET – scans.	12

Text Books:

1. Handbook of Biomedical Instrumentation , R S Khandpur, Tata –Mcgraw Hill Education [Partly Downloadabl e]
2. Understanding the Human Machine- A Primer for Bioengineering, M E Valentiniuzzi [Freely Downloadable in PDF], World Scientific Publishing Co.
3. Biomedical Instrumentation and Measurements, L Cornwell, F.J. Weibell& E.A. Pfeiffer, Prentice Hall.
4. Medical Instrumentation – Application & Design, J G Webster & J W. Clark , Houghton Miffin Publication.
5. Introduction to Bio-medical Equipment Technology, J J Carr & JM Brown Regents , Prentice Hall.
6. Design of Micro- controller based Medical Instrumentation, J Tompkins & J G Webster, Prentice Hall Inc

Reference Books:

1. A systems approach to Biomedicine, W.B. Blesser , McGraw Hill..
2. Biomedical Engineering, J H U Brown, J E Jacobs & L Stark, Davis Co, Philadelphia, USA.
3. Principles of Applied Biomedical Instrumentation, L A Geddes & L E Baker, John Wiley & sons.

Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)
Syllabus for B. Tech in Instrumentation and Control Engineering (ICE)
(Applicable from the academic session 2018-2019)

PE-IC601	**Power Electronics & Drivers**	**3L:0T:0P**	**3 credits**

Course Outcomes:
At the end of this course students will demonstrate the ability to
- Understand the differences between signal level and power level devices.
- Analyse thyristor and controlled rectifier circuits.
- Analyse the operation of DC-DC choppers.
- Analyse the operation of voltage source inverters.

Module 1: Power switching devices (8 Hours)
Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module 2: Thyristor rectifiers (7 Hours)
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with Rload and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Module 3: DC-DC converters (5 Hours)
Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers and switching mode regulators.

Module 4: Inverters (10 Hours)
Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. Brief idea of Resonant Pulse inverters.

Module 5: AC controllers (6 Hours)
Principle of on-off and phase control, single phase and three phase controllers with R and R-L loads. Principle of operation of cycloconverters, circulating and non circulating mode of operation, single phase to single phase step up and step down

cycloconverters, three phase to single phase Cycloconverters, three phase to three phase Cycloconvetter.

Module 6: Applications:
Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS, static VAR controller.

Text/References:
1. M. H. Rashid, "*Power electronics: circuits, devices, and applications*", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

5. Power Electronics, P.S. Bhimra, Khanna Publishers, 3rd Edition.

PE-IC602	**Microelectronics and VLSI Technology**	**3L:0T:0P**	**3 credits**

Introduction to VLSI Design: VLSI Design Concepts, Moor's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI – basic idea only), Types of VLSI Chips (Analog & Digital VLSI chips, General purpose, ASIC, PLA, FPGA), Design principles (Digital VLSI – Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural, Physical), Y-Chart, Digital VLSI Design Steps.

MOS structure: E-MOS & D-MOS, Charge inversion in E-MOS, Threshold voltage, Flat-band voltage, Potential balance & Charge balance, Inversion, MOS capacitances.
Three Terminal MOS Structure: Body effect.
Four Terminal MOS Transistor: Drain current, I-V characteristics. Current-voltage equations (simple derivation).

Scaling in MOSFET: Short Channel Effects, General scaling, Constant Voltage & Field scaling.
CMOS: CMOS inverter, Simple Combinational Gates - NAND gate and NOR Gate using CMOS.
Micro-electronic Processes for VLSI Fabrication: Silicon Semiconductor Technology- An Overview, Wafer processing, Oxidation, Epitaxial deposition, Ion-implantation & Diffusion, Cleaning, Etching, Photo-lithography – Positive & Negative photo-resist
Basic CMOS Technology – (Steps in fabricating CMOS), Basic n-well CMOS process, p-well CMOS process, Twin tub process, Silicon on insulator
Layout Design Rule: Stick diagram with examples, Layout rules.

Hardware Description Language – VHDL or Verilog Combinational & Sequential Logic circuit Design.

Text Books:
1. Digital Integrated Circuit, J.M.Rabaey, Chandrasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuit, S.M.Kang&Y.Leblebici, TMH.
3. Modern VLSI Design, Wayne Wolf, Pearson Education.
4. VHDL, Bhaskar, PHI.
5. Advance Digital Design Using Verilog , Michel D. Celliti, PHI

References:
1. Digital Integrated Circuits, Demassa & Ciccone, John Willey & Sons .
2. Modern VLSI Design: system on silicon, Wayne Wolf; Addison Wesley Longman Publisher
3. Basic VLSI Design, Douglas A. Pucknell & Kamran Eshranghian, PHI
4. CMOS Circuit Design, Layout & Simulation, R.J.Baker, H.W.Lee, D.E. Boyee, PHI.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:
1. Understand VLSI design flow in industry.
2. Understand the CMOS design using transistor and industry based fabrication technology for IC design.
3. Understand hardware description language to design various digital sub systems.

Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)
Syllabus for B. Tech in Instrumentation and Control Engineering (ICE)
(Applicable from the academic session 2018-2019)

OE-IC601	**IOT**	**3L:0T:0P**	**3 credits**

Introduction to IoT (6 Hours)
Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs

IoT & M2M (6 Hours)
Machine to Machine, Difference between IoT and M2M, Software define Network

Network & Communication aspects (13 Hours)
Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination

Challenges in IoT (10 Hours)
Design challenges, Development challenges, Security challenges, specific applications of IoT-
Home automation, Industry applications, Surveillance applications.

Developing IoTs (10 Hours)
Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python

Reference Books:
1. Jeeva Jose, "Internet of Things", Khanna Publishing House
2. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach"
3. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
4. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things"

Course Outcome:
- Understand the concepts of Internet of Things
- Analyze basic protocols in wireless sensor network
- Design IoT applications in different domain and be able to analyze their performance

- Implement basic IoT applications on embedded platform

OE-IC 602	**Artificial Intelligence**	**3L:0T:0P**	**3 credits**

Learning Objectives:

The search and problem solving methods are applicable throughout a large range of industrial, civil, medical, financial, robotic, and information systems. We will investigate questions about AI systems such as: how to represent knowledge, how to effectively generate appropriate sequences of actions and how to search among alternatives to find optimal or near-optimal solutions.

By the end of the course, students should be able to:

Identify the type of an AI problem (search, inference, decision making under uncertainty, game theory, etc). Formulate the problem as a particular type. Compare the difficulty of different versions of AI problems, in terms of computational complexity and the efficiency of existing algorithms. Implement, evaluate, and compare the performance of various AI algorithms, including both empirical demonstration and theoretical proofs.

Introduction [2 hours]

Overview of Artificial intelligence- Problems of AI, AI technique, Tic - Tac - Toe problem.

Intelligent Agents [2 hours]

Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents.

Problem Solving [2 hours]

Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.

Search techniques [5 hours]

Solving problems by searching: problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies.

Heuristic search strategies [4 hours]

Greedy best-first search, A* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search, genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems.

Adversarial search [3 hours]

Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.

Knowledge & reasoning [3 hours]

Knowledge representation issues, representation & mapping, approaches to knowledge representation, issues in knowledge representation.

Using predicate logic [2 hours]

Representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction.

Representing knowledge using rules [3 hours]

Procedural verses declarative knowledge, logic programming, forward verses backward reasoning, matching, control knowledge.

Probabilistic reasoning [3 hours]

Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Fuzzy sets & fuzzy logics.

Planning [2 hours]

Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques.

Natural Language processing [2 hours]

Introduction, Syntactic processing, semantic analysis, discourse & pragmatic processing.

Learning [3 hours]

Forms of learning, inductive learning, learning decision trees, explanation based learning, learning using relevance information, neural net learning & genetic learning.

Expert Systems [2 hours]

Representing and using domain knowledge, expert system shells, knowledge acquisition.

Basic knowledge of programming language like Prolog & Lisp. [3 hours]

Books:

1. Artificial Intelligence, M.C. Trivedi, Khanna Publishing House

2. Artificial Intelligence, Ritch & Knight, TMH

3. Artificial Intelligence A Modern Approach, Stuart Russel Peter Norvig Pearson

4. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI

5. Poole, Computational Intelligence, OUP

6. Logic & Prolog Programming, Saroj Kaushik, New Age International

7. Expert Systems, Giarranto, VIKAS

8. Artificial Intelligence, Russel, Pearson

MC-ES601	**Indian Constitution and culture**	**1L:0T:0P**	**0 credits**

Course content

1. Meaning of the constitution law and constitutionalism

2. Historical perspective of the Constitution of India

3. Salient features and characteristics of the Constitution of India

4. Scheme of the fundamental rights

5. The scheme of the Fundamental Duties and its legal status

6. The Directive Principles of State Policy – Its importance and implementation

7. Federal structure and distribution of legislative and financial powers between the Union and the States

8. Parliamentary Form of Government in India – The constitution powers and status of the President of India

9. Amendment of the Constitutional Powers and Procedure

10. The historical perspectives of the constitutional amendments in India

11. Emergency Provisions : National Emergency, President Rule, Financial Emergency

12. Local Self Government – Constitutional Scheme in India

13. Scheme of the Fundamental Right to Equality

14. Scheme of the Fundamental Right to certain Freedom under Article 19

15. Scope of the Right to Life and Personal Liberty under Article 21.

PC-IC 691	**PROCESS CONTROL LABORATORY**	**0L:0T:3P**	**1.5 credits**

PROCESS CONTROL LABORATORY - PC-IC691

1. Study of Flow, Level, Pressure, Temperature processes and construction of the P&I diagram in accordance with ISA guidelines/standards.
   2. Study of a typical temperature control loop having furnace suitable, suitable final control elements, Temperature transmitter, conventional PID controller/ control system.
   3. Study of typical pressure control loop having pressure source, Pressure transmitter, Motorized/Pneumatic control valve and conventional PID controller/control system
   4. Study of typical flow control loop having suitable flow meter, motorized/pneumatic control valve and conventional PID controller/control system
   5. Study of typical level control loop having suitable flow meter, motorized/pneumatic control valve and conventional PID controller/control system

6. Study of typical air duct flow monitoring and control.
7. PLC programming through PC.
8. Study of a PC based automation software /simulation software.
9. PLC and DCS based instrumentation experiments.

PC-IC 692	**Instrumentation system Design Lab**	**0L:0T:3P**	**1.5 credits**

1. Design of instrumentation amplifiers
2. Design of active filters
3. Design of regulated power supply.
4. Design of V/I and I/V converters
5. Design of linearising circuit and cold – junction compensation circuit for thermocouples
6. Design of signal conditioning circuits for strain gauge and RTD
7. Design of orifice plate and rotameter
8. Design of control valve (sizing and flow – lift characteristic)
9. Design of PID controllers (using operational amplifier and microprocessor)
10. Piping and Instrumentation Diagram – case study
11. Preparation of documentation of instrumentation project (process flow sheet, instrument index sheet and instrument specifications sheet
12. Preparation of project scheduling (Job scheduling, installation procedure and safety regulations).

OE-IC691	**IOT Lab**	**0L:0T:3P**	**1.5 credits**

1. Define and Explain Eclipse IoT Project.

2. List and summarize few Eclipse IoT Projects.

3. Sketch the architecture of IoT Toolkit and explain each entity in brief.

4. Demonstrate a smart object API gateway service reference implementation in IoT toolkit.

5. Write and explain working of an HTTP- to-CoAP semantic mapping proxy in IoT toolkit.

6. Describe gateway-as-a-service deployment in IoT toolkit.

7. Explain application framework and embedded software agents for IoT toolkit.

8. Explain working of Raspberry Pi.

9. Connect Raspberry Pi with your existing system components.

10. Give overview of Zetta.

Design based Problems (DP)/Open Ended Problem:

1. How do you connect and display your Raspberry Pi on a Monitor Or TV?

2. Create any circuitry project using Arduino.

Major Equipment:

Raspberry pi, Arduino

OE-IC 692	**Artificial Intelligence Lab**	**0L:0T:3P**	**1.5 credits**

1. Study of facts, objects, predicates and variables in PROLOG.

2 Study of Rules and Unification in PROLOG.

3 Study of "cut" and "fail" predicate in PROLOG.

4 Study of arithmetic operators, simple input/output and compound goals in PROLOG.

5 Study of recursion in PROLOG.

6 Study of Lists in PROLOG.

7 Study of dynamic database in PROLOG.

8 Study of string operations in PROLOG. Implement string operations like substring, string position, palindrome etc.)

9 Write a prolog program to maintain family tree.

10 Write a prolog program to implement all set operations (Union, intersection, complement etc.)

11 Write a prolog program to implement Library Management system.

12 Write a prolog program to solve "Water Jug Problem".

Learning Outcome:

On successful completion of the course, the student will:

1. Be familiar with Artificial Intelligence, its foundation and principles.

2. Examine the useful search techniques; learn their advantages, disadvantages and comparison.

3. Learn programming language to program intelligent systems.

4. Understand important concepts like Expert Systems, AI applications.

5. Be exposed to the role of AI in different areas like NLP, Pattern Recognition etc.

6. Learn the practical applicability of intelligent systems, specifically its applications.

7. Be able to develop intelligent systems.