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**SECOND SEMESTER 2022-2023**

COURSE HANDOUT PART II

# Date: 16.01.2023

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

**Course No. : INSTR F343**

**Course Title : Industrial Instrumentation & Control**

**Instructor-in-charge : R. N. Ponnalagu**

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1. **Course Description:** Importance of process control, elements of process loop, mathematical modeling, dynamic closed loop characteristics, controller principles & tuning, direct digital loop, hydraulic controllers, pneumatic controllers, electronic controllers, complex & multivariable control schemes, final control elements, P&I diagrams, PLCs, Distributed Control Systems (DCS), AI techniques: expert systems, neural networks, fuzzy logic, genetic algorithms & applications.
2. **Scope and Objective of the Course:** This course aims to develop an insight of the industrial instrumentation and control aspects for UG students of Electronics and Instrumentation Engineering. The uses of different controllers, their types, their implementation aspects are detailed in the course. The course starts from the basic control loop element identification and understanding of various elements. Further, an exposure to various control configurations often found in industrial control loops will be discussed so as to enable the student to have an effective understanding of the real industrial control loops and justify their use. The next module of the course deals with programmable logic controllers and also discusses the digital control and distributed control aspect from a higher level, which will make the students to comprehend the control layers in an industry with a recent advancement i.e. industry 4.0 along with basic concepts of IIoT. The last part of the course is intended to make the students familiarize with advanced sophisticated control techniques with the help of intelligent control which includes fuzzy and neural based control techniques. After learning the course, the students will be able to understand the control loop architecture for an industrial use and will be able to design a low-level control algorithm as well.
3. **Text Books**: Surekha Bhanot, Process Control: Principles and Applications, Oxford University press, Fourth Impression 2010.

**4. Reference Books:**

R1: C.D. Johnson, Process Control Instrumentation Technology, Prentice Hall of India, New Delhi, 1993

R2: Krishan Kant, Computer Based Industrial Control, Prentice Hall of India, New Delhi, 1997.

R3: Stephanopoulos George, Chemical Process Control, Prentice Hall of India

R4: Ogata K., Modern Control Engineering, Pearson Education Asia

R5: Sigh, S. K., Industrial Instrumentation & Control, Tata McGraw-Hill Education

1. **Course plan**

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| --- | --- | --- | --- |
| **Lecture**  **No.** | **Learning Objective** | **Topics to be covered** | **Chapter in the Text Book** |
| 1, 2 | To understand and appreciate the needs, objectives of process control | Basic Control loop, variables, requirements, aims, parameters, dynamics of the process | T-CH1  R4 (1.9) |
| 3 | To understand the dynamics of processes | Terms, concepts used in process dynamics | T-CH2 |
| 4, 5 | Understanding the need and ways to develop mathematical modelling | Modelling aspects of different processes | T-CH2, R3 |
| 6 | To understand steady state and transient analysis | Transient and steady state analysis of first order, second order and higher order systems and numerical to highlight concepts | R5-CH5 |
| 8 - 11 | To understand different controller modes | On-off, on-off with neutral zone, Proportional, Integral, derivative, PI, PD, PID | T-CH3, R4(9), R3 – CH1 |
| 12 - 14 | Student will be able to realize analog electronic PID controllers | Electronic realization of P, PI and PID controllers through operational amplifiers | T-CH7, R1 |
| 15,16 | To learn dynamic behavior of feedback-controlled systems | Effect on dynamic behavior of process with different controller modes in closed loop mode | T-CH4, R4(14) |
| 17,18 | To learn about controller tuning and their effects on control loop performance | Ziegler, Cohen-Coon, Integral performance | T-CH4, R4 |
| 19, 20 | Understanding of digital implementation of control  algorithms | Sampling and reconstruction, DDC structure, position & velocity algorithm | T-CH5 |
| 21 | To realize controller modes in pneumatic and hydraulic controllers | Pneumatic and Hydraulic controllers | T-CH6, R5 (4.3 and 4.4) |
| 22, 23 | Understanding of the function of final control elements | Functions of control valves, Types of control valves, actuators | T-CH8, R3 CH4 |
| 24 | Student Will be able to understand and draw P&I diagrams | Piping & Instrumentation Diagrams | T-CH9, R1 |
| 25 - 29 | Students will be able to understand different control configuration | Cascade control and Ratio control, Inferential control and Adaptive control, feed forward control | T-CH10, R3 |
| 30, 31 | Student will be able to understand multivariable control problems | Multi variable control | T-CH12, R3 |
| 32 - 36 | Students will be able to understand and develop sequential programming  for control aspects | PLC vs relay Logic, PLC vs PCs, hardware components  Ladder diagram, selection of PLCs | T-CH13, R3(5), R2 |
| 37, 38 | To learn application of AI and fuzzy techniques in process control | Neural networks and their application in control, Fuzzy based control, Fuzzy PID control | T-CH14, CH17, R3(13), R2 |
| 39, 40 | Student will understand the concept of distributed digital control systems | Distributed digital control system: Functional requirements, system architecture | T-CH18, R2, R3, R5 |
| 41 - 42 | Student will understand the basics of Industry 4.0 and IoT use in industries | Industry 4.0: Concepts, Terms and d efinitions; Industrial Internet, IIoT | Class notes |

1. **Evaluation Scheme**

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| --- | --- | --- | --- | --- | --- |
| **Components** | **Duration** | **Weightage** | **Marks** | **Date & Time** | **Nature of Component** |
| Midsem | 90 minutes | 30 % | 60 | 18/03 2.00 - 3.30PM | Closed Book |
| Quizzes (3) | 20 minutes | 15 % | 30 | TBA | Closed Book |
| Term Paper / Assignments | - | 15 % | 30 | Take Home | Open Book |
| Comprehensive | 180 minutes | 40 % | 80 | 20/05 FN | 10 % Open book and 30% Closed book |
| Total |  | 100 % | 200 |  |  |

**7. Chamber Consultation Hour**: To be announced in the class.

**8. Notices:** Will be displayed on the course page in CMS

**9. Make-up Policy:** No make-up will be given for the quizzes, however, for other components, make-up examination will be given ONLY in cases of sickness (hospitalization) or urgency for going out of station. In such a case, the student must produce sufficient proof or must have taken the prior permission from the IC of the course.

**10. Academic Honesty and Integrity Policy:**

Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-charge INSTR F343**