1. Identify the components of solar flat plate collector.
2. Use pyranometer for measurement of solar radiation flux density.
3. Assemble a solar PV system with and without battery connection.
4. Measure heat output, Maximum power, power output efficiency of solar PV panel.
5. Use vane anemometer for measurement of different locations for site selection for wind mill.
6. Industrial visit
7. Project based on sustainable technologies.
8.

Essential/recommended readings

1. C. S. Solanki, *Solar Photovoltaics*. PHI Learning Pvt. Ltd., 2015.
2. Solar energy, 4th edn , January 2017 by S P Sukhatme and J K Nayak
3. T. Ackermann, *Wind Power in Power Systems*. John Wiley & Sons, 2012.
4. D. P. Kothari, *Renewable Energy Sources and Emerging Technologies*. 2022.
5. V. C. Nelson, *Introduction to Bioenergy*. CRC Press, 2017.

Suggestive readings

1. K. Lovegrove, *Concentrating Solar Power Technology*. Elsevier, 2012.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time

GENERIC ELECTIVE COURSE: Instrumentation and Control (INGE7A)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Instrumentation and Control (INGE7A)	04	03	-	01	Course admission eligibility	Basic instrumentation

Learning Objectives

The Learning Objectives of this course are as follows:

- To study about how to analyse the stability and response of the closed and open loop systems
- To teach students about how to develop the mathematical model of the physical systems
- To study about how to analyse performance characteristics of system using Frequency response methods
- To study how to compute gain and phase margins from Bode diagrams and Nyquist plots and understand their implications in terms of robust stability

Learning Outcomes

After successful completion of the course, students will be able to:

- Analyze the stability and response of the closed and open loop systems
- Develop the mathematical model of the physical systems
- Analyze performance characteristics of system using Frequency response methods
- Compute gain and phase margins from Bode diagrams and Nyquist plots and understand their implications in terms of robust stability
- Handle different types of controller like electronic, pneumatic and hydraulic

SYLLABUS

Unit-I **(13 hours)**

Basic concepts of Instrumentation: Generalized Instrumentation systems, block diagram representation, scope of instrumentation in Industrial organization.

Transducers: Active and Passive transducers, Mechanical transducers and Electrical transducers, Introduction to Resistive, Capacitive, Inductive, light (Photo-conductive, Photo-emissive, Photo-voltaic), Temperature transducers (RTD, thermocouple).

Unit-II **(12 hours)**

Signal Generators-Audio oscillator, Function generators, Pulse generators, RF generator, and Random noise generator.

Controller Hardware: Electronic pneumatic and hydraulic controller's implementation, single and composite modes of controller

Unit-III **(10 hours)**

Basics of control system: Open loop and closed loop control systems, mathematical modeling of physical systems, transfer function. Effect of feedback on control systems.

Time – Domain Analysis and Stability: Time domain performance criteria, transient response of first and second order systems. Asymptotic stability and conditional stability, relative stability analysis.

Unit-IV **(10 hours)**

Frequency Domain Analysis: Correlation between time and frequency response, frequency domain specifications.

Final Control Elements: Control valves types, actuators, Solenoid, I/P P/I converters, stepper motors.

Practical Components **(30 Hours)**

Some of the experiments mentioned can be simulated on software (MATLAB/MathCAD/LabVIEW/SciLab)

1. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO, DSO.
2. To measure displacement using capacitive transducer
3. To measure displacement using LVDT
4. Measuring change in resistance using LDR
5. Measurement of Temperature using Temperature Sensors.
6. To study position control of DC motor
7. To study speed control of DC motor
8. To study time response of first and second order systems.
9. To study the effect of the damping factor on performance of second order systems.

Essential/Recommended readings

1. K. Ogata, Modern Control Engineering, PHI 2010, 5th Edition by Pearson.
2. B. C. Kuo , "Automatic control system", 2002, 8th Edition by John Wiley & Sons.
3. I. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2017, 5th Edition.
4. Nakra &Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 4th Edition (2016).

Suggestive readings

1. Johnson .C.D., Process Control Instrument Technology, Prentice Hall Inc, 8thEdition (2006).

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GENERIC ELECTIVE COURSE: Photovoltaic Technology and Applications (INGE7B)

Credit distribution, Eligibility and Pre-requisites of the Course