ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati

Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B. TECH

INSTRUMENTATION ENGINEERING

4th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

Course Structure
(From Academic Session 2018-19 onwards)

B.Tech 4th Semester : Instrumentation Engineering
Semester IV/ B.TECH/IE

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	EI181401	Electrical Measurements	3	1	0	4	30	70
2	EI181402	Control Systems	3	1	0	4	30	70
3	IE181403	Industrial Instrumentation	3	1	0	4	30	70
4	IE181404	Electrical Machines	3	1	0	4	30	70
5	EI181405	Signals and Systems	3	0	0	3	30	70
6	MC181406	Environmental Science	2	0	0	0 (PP/NP)	-	100
Practical								
1	EI181412	Control Systems Lab	0	0	2	1	15	35
2	IE181414	Electrical Machines Lab	0	0	2	1	15	35
3	IE181417	Instrumentation Lab-II	0	0	2	1	15	35
TOTAL			17	4	6	**22**	**195**	**555**
Total Contact Hours per week : 27								
Total Credit: 22								

NB: 1. MC181406 is a Mandatory Audit Course (No Credit). It will be evaluated as PP (Pass) or NP (Not Pass)
2. 2-3-weeks Mandatory Academia Internship need to be done in the 4th semester break and the report is to be submitted and evaluated in 5th semester

Detail Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181401	**Electrical Measurements**	**3-1-0**	**4**

Prerequisites:

- Higher School Physics
- Higher School Mathematics
- Basic concept of Electrical Engineering

COURSE OBJECTIVES:

- Explanation of fundamental measuring concept in various measuring instruments and their practical applications in Electrical Engineering and Instrumentation Engineering fields.

COURSE OUTCOMES:

At the end of this course, the students will be able to

CO1:

Students will be able to understand the basic concept of static and dynamic characteristics of an instrument and along with that they will be able to identify different types of measuring instruments.

CO2:

Students will be able to describe the working principle of different types of instruments along with their applications in electrical engineering field.

CO3:

Students will be able to compute electrical voltage, current, power, power loss, energy, frequency, power factor, flux density, iron loss, permeability etc. and physical parameters like pressure, flow speed etc. using different types of instruments and methods.

CO4:

Students will be able to compute the electrical parameters (R, L, C, frequency etc.) using DC and AC Bridge with the help of different methods

CO5:

Students will be able to understand the working principle, construction and applications of an instrument transformers and the potentiometer.

MODULE 1: Characteristic of Instruments and Measuring Systems (2 Lectures)

Static characteristic – accuracy, sensitivity, reproducibility, drift, static error and dead zone. Dynamic characteristic- response to step and sinusoidal signals. Errors occurring in measurement.

MODULE 2: Measuring Instruments (6 Lectures)

Electro-dynamic, rectifier and induction type ammeters and voltmeters – construction, operation, errors and compensation, Electro-dynamic and induction type watt meters, Single phase induction type energy meter. MC and MI type power factor meters. Electrodynamometer type frequency meter, Synchroscope. Digital Voltmeters and Ammeters, Digital Wattmeters and Energy Meters Electro-dynamic, rectifier and induction type ammeters and voltmeters – construction, operation, errors and compensation, Electro-dynamic and induction type watt meters, Single phase induction type energy

meter. MC and MI type power factor meters. Electrodynamometer type frequency meter, Synchroscope. Digital Voltmeters and Ammeters, Digital Wattmeters and Energy meters.

MODULE 3: Sensors and Transducers (3 Lectures)

Sensors and Transducers for physical parameters: temperature, pressure, torque, flow, Speed and Position Sensors; Hall Sensors.

MODULE 4: Measurement of Resistance (4 Lectures)

Wheatstone bridge method – sensitivity of the Wheatstone Bridge – precautions to be taken while making precision measurements, Limitations, Carey-Foster slid Wire Bridge.
Measurement of low resistance – Kelvin's Double Bridge.
Measurement of high resistance – direct deflection method. Measurement of volume and surface receptivity. Loss of charge method. Measurement of insulation resistance with power on.

MODULE 5: Potentiometers (5 Lectures)

D. C. potentiometer – basic principle. Laboratory type potentiometer. Methods of standardization. Applications- calibration of ammeters and voltmeters, measurement of resistance and power - calibration of watt meters. Volt ratio box, A. C. potentiometers – difference between A. C. and D. C. potentiometers. Types - polar and co-ordinate type. Application of A. C. potentiometer.

MODULE 6: A. C. Bridge (4 Lectures)

General principle, Balance equation. Sources and Detectors used in A. C. Bridges. Balance condition and Phasor diagrams of Maxwell's bridge, Anderson's bridge, Owen's bridge, De Sauty's bridge, Low voltage Schering Bridge, Heavy-side mutual inductance Bridge.

MODULE 7: Magnetic Measurement (3 Lectures)

Magnetic hysteresis, alternating current magnetic testing, separation of iron losses. Measurement of iron losses by the watt meter method, Cambell's bridge method and the Oscillo graphic method.

MODULE 8: Instrument Transformer (5 Lectures)

Use of instrument transformers – ratio, burden. Theory and operation of CTs and PTs – errors and compensation – CT testing – mutual inductance method, Silbee's method. PT testing – comparison method. Power and energy measurement using CTs and PTs. Effect of reverse polarity connection of one of the CTs on 3-phase energy meter.

MODULE 9: C.R. O (2 Lectures)

Basic construction, main parts, principle of operation, Applications.

Text Books:

1. Golding and Widdis – Electrical Measurements and measuring instruments. AH WHEELER & Company
2. A.K. Sawhney – Electrical and Electronic Measurements and Instrumentation Dhanpat rai & Co

Reference Books:

1. Electronic Instrumentations H.S. Kalsi
2. Electrical Measurement and Measuring Instruments by U.A Bakshi, A.V. Bakshi

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181402	**Control Systems**	**3-1-0**	**4**

Prerequisites: Laplace transforms techniques

COURSE OBJECTIVES:

- To introduce the fundamental concepts of control systems
- To study the time domain analysis of control systems
- To study the stability of control systems

COURSE OUTCOMES:

At the end of this course, the students will be able to

CO1: Define, classify and compare different types of control systems
CO2: Derive transfer function of control systems
CO3: Analyze and determine the time response of control systems
CO4: Analyze stability of control systems using analytical and graphical techniques
CO5: Apply analytical and graphical techniques to design control systems

MODULE 1: Elementary Concepts of Control Systems
Definition, open loop and closed loop systems, definitions and examples of linear, non-linear, time-invariant and time variant, continuous and discrete control system, block diagram representation of control systems.

MODULE 2: Models of Physical Systems
Transfer function: definition and properties, poles, zeros and pole-zero map, formulation of differential equations for physical systems and derivation of transfer function: mechanical and electrical systems, derivation of transfer function using block diagrams reduction techniques and signal flow graphs, signal flow graph from block diagram, analogous systems.

MODULE 3: Introduction to Control System Components
Error detectors, rotary potentiometers, servomotors, tacho-generators, servo amplifiers and determination of transfer functions.

MODULE 4: Time Domain Analysis:
Concept of transient response and steady-state response, standard test signals - step, ramp, parabolic and impulse signals, time response of first order and second order systems, closed loop transfer function, characteristic equation, performance specifications in time domain, derivative and integral control and their effects on the performance of the 2^{nd} order systems, system types and error constants, generalized error coefficients, transient response of higher order systems (outline only).

MODULE 5: Stability Analysis
Concepts of control system stability, relation between stability and pole locations, Routh-Hurwitz stability criterion, scopes and limitations of the criterion, root-locus techniques, system analysis and design using root-locus technique.

MODULE 6: Frequency Response Analysis
Frequency response and its specifications, stability analysis using frequency response plots: Bode plot, polar plot, log-magnitude vs phase plots, Nyquist plot and Nyquist stability criterion, M and N circle.

MODULE 7: Compensation Techniques
Preliminary design specifications in time and frequency domain, gain compensation, lead and lag compensation.

Text Books:

1. Nagrath and Gopal: Control Systems Engineering
2. K Ogata: Modern Control Engineering

Reference Books:

1. B Kuo: Automatic Control Systems
2. A Anand Kumar: Control Systems
3. Salivahanan, Rengaraj and Venkata krishnan: Control Systems Engineering
4. Gibson and Teylor: Control System Components

Course Code	Course Title	Hours per week L-T-P	Credit C
IE181403	**Industrial Instrumentation**	**3-1-0**	**4**

COURSE OUTCOMES:
At the end of this course, the students will be able to

CO1: Select suitable vacuum and medium pressure measurement sensors.
CO2: Choose a proper flow and level sensors for industrial measurements.
CO3: Identify the relevant force, torque, velocity and acceleration sensors for industrial applications.
CO4: Apply the concept of digital data acquisition system in industrial applications

MODULE 1: Introduction to Metrology (4 Lectures)

MODULE 2: Pressure Measurement (10 Lectures)

(Low pressure & High Pressure)-Manometers, Diaphragm, Bellows, Bourdon tubes etc. Electrical Pressure measuring instruments, Vacuum measurement – Mcleod gauge, Pirani gauge, Knudsen gauge, Ionization gauge etc.

MODULE 3: Flow Measurement (8 Lectures)

Mechanical type - Head type, Area type, Mass flow meter, Electrical type – Electromagnetic, Ultrasonic, Hotwire, Anemometers and Digital type.

MODULE 4: Level Measurement (8 Lectures)

Resistive, inductive and capacitive techniques for level measurement, Ultrasonic and radiation methods, Air purge system (Bubbler method) and their industrial applications.

MODULE 5: Measurement of (12 Lectures)

Force, torque, revolution, velocity, acceleration, vibration, viscosity, humidity etc. detail discussion about accelerometer, vibrometer, viscometer, hygrometer, densitometer etc.

MODULE 6: Digital Data Acquisition Systems and Control (10 Lectures)

Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition. Instrumentation systems. Types of Instrumentation systems. Components of an analog Instrumentation Data – Acquisition system. Multiplexing systems. Uses of Data Acquisition systems. Use of Recorders in Digital systems. Digital Recording systems. Modern Digital Data Acquisition system. Analog Multiplexed operation, operation of sample Hold circuits.

Text/Reference Books:

1.Doebelin E.O – Measurement Systems: Applications and Design (Mc Grow Hill)
2. Patranibis D – Principles of Industrial Instrumentation
3. Jones B.E – Instrument Technology (Vol-I & II)

4. Backwith T. G ,Buch N. L and Marangoni R.D – Mechanical Measurements
5. K.Krishnaswamy- Industrial Instrumentation (New Age)
6. Eckman D.P – Industrial Instrumentation (WE)
7. Instrumentation Measurement and Analysis- B C Nakra, K K Chaudhry
8. R.K.Jain, “Mechanical and Industrial Measurements”, Khanna Publishers, New Delhi.

Course Code	Course Title	Hours per week L-T-P	Credit C
IE181404	**Electrical Machines**	**3-1-0**	**4**

PREREQUISITES:

- Basic knowledge of electrical and magnetic circuits and electromagnetic induction

OBJECTIVES:

- To give an idea about the principle of operation, working and performance of D.C. machines and A.C. machines

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Relate the principles of electromagnetic energy conversion and electromagnetic induction to operation of electrical machines.
CO2: Solve simple numerical problems of D.C. machines (both motors and generators).
CO3: Determine losses of a transformer and its efficiency at various load conditions
CO4: Explain the working of an induction motor and solve simple numerical problems.
CO5: Explain the working principle and applications of servo motor, stepper motor and BLDC motor.

MODULE 1: Electromagnetic Induction and Electromechanical Energy Conversion (2 Lectures)

Review of magnetic circuits, MMF, Faraday's Law of Electromagnetic induction, magnetically coupled circuits Basic principles of energy conversion, dynamically induced e.m.f. and torque in rotating machines.

MODULE 2: D.C. Machines

(i) Generators: Constructional features, Types of Armature windings, Methods of excitations-shunt, series and compound. E M F equation, Armature reaction, Characteristic of generators, Losses, Efficiency and Regulation, Parallel operation **(6 Lectures)**

(ii) Motors: Torque equation of motors, Speed and Torque characteristic curves of shunt, series and compound motors, Losses and efficiency. Starting of D C motors and Starters. Speed control- conventional methods and solid state control, Choice of motors for different duties. **(5 Lectures)**

MODULE 3: Transformers (10 Lectures)

Principles of operation of transformer, voltage and current ratios, Construction – shell type and core type, single phase and poly phase, cooling methods, E.m.f. equation. Transformer circuit parameters, equivalent circuit, Phasor diagrams on no-load and on load. Open circuit and short tests. Regulation, losses and efficiency, maximum efficiency, all-day efficiency. 3-phase transformer, Auto-transformer, and instrument transformer.

MODULE 4: A.C. Motors **(12 Lectures)**

3 phase Induction motor: Constructional features (frame, magnetic circuit, stator and rotor electric circuits) and working principle - production of rotating magnetic field and development of torque. Slip speed and slip, torque equations. Torque-slip characteristic. Effect of variation of applied voltage and rotor resistance. Power stages, losses and efficiency. Starting and speed control. Single phase induction motors: principle, double revolving field theory. Starting arrangement of single phase motor and its applications. Comparison between single phase and three phase motors. Brief Introduction of Synchronous Motor.

MODULE 5: Special Motors **(8 Lectures)**

Introduction to special Machines- Servo Motor, Linear Induction Motors, Stepper Motors, Brushless DC Motors and their applications in Instrumentation Systems.

Text Books:

1. Nagrath D.P. & Kothari I.J, " Electrical Machines", Tata McGraw Hill Education
2. Bimbra, P.S., "Electric Machinery", Khanna Publishers
3. Mehta V.K. and Mehta, R. "Principle of Electrical Machines", S. Chand and Co.

Reference Books:

1. Langsdrof A.S: Theory of Alternating Current Machinery, McGraw Hill Education
2. Chapman.J, “Electric Machinery Fundamentals”, McGraw Hill Book Co.
3. Fitgerald, A.E., Charles Kingsely Jr. Stephen D.Umans, “Electric Machinery” McGraw Hill Books Company
4. J.B. Gupta, "Theory & Performance Of Electrical Machines" Katsons Books

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181405	**Signals and Systems**	**3-0-0**	**3**

COURSE OBJECTIVES

1. To study fundamental concepts of signals, its processing and systems
2. To study mathematical tools for signal analysis

COURSE OUTCOMES (CO)

After successful completion of the course student should be able to:

CO1: Identify various types of signals in continuous-time and discrete-time domain

CO2: Understand Linear Time Invariant (LTI) system and its properties to obtain the response of the system using convolution sum and convolution integral

CO3: Apply knowledge of Fourier Series and Fourier Transform to obtain the frequency domain representation and analysis of signals and systems

CO4: Apply sampling techniques for processing of signals

CO5: Apply knowledge of Z transform and LTI system to design and realize digital filters: FIR and IIR filters

MODULE 1: Introduction to Signals And Systems (6 Lectures)
Definitions, continuous-time (CT) and discrete-time (DT) signals, exponential and sinusoidal signals, signal energy and power, even and odd signals, periodic signals, transformation of independent variables: time-shift, time-reversal and time-scaling, CT and DT systems and their classification, basic properties of CT and DT systems.

MODULE 2: LTI Systems (6 Lectures)
DT LTI systems: convolution sum, CT LTI systems: convolution integral, properties of LTI systems: commutative, distributive and associative properties, LTI systems with and without memory, invertibility, causality and stability of LTI systems, systems described by differential and difference equations, block diagram of LTI systems

MODULE 3: Fourier Series Analysis of Signals (5 Lectures)
Response of LTI systems to complex exponential, representation of periodic signals: The Fourier series, properties of Fourier series, convergence of Fourier series.

MODULE 4: Fourier Transform Analysis of Signals (6 Lectures)
Representation of a-periodic signals: The Fourier Transform, properties of Fourier transform, System analysis by Fourier Transforms, convergence of Fourier transform.

MODULE 5: Sampling (5 Lectures)
Sampling theorem, effect of under-sampling, reconstruction of a signal from its samples, Spectrum of sampled signal.

MODULE 6: Z-Transform **(6 Lectures)**

Definitions, region of convergence, properties of Z-transform, inversion of Z-transforms, system function, applications to system analysis.

MODULE 7: Digital Filters **(6 Lectures)**

Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) systems, FIR and IIR filters, realization of FIR and IIR systems

Text Books:

1. Oppenheim, A.V., Willsky, A.S., Nawab, S. H.: Signals and Systems, Prentice Hall India
2. Rawat, T.K.: Signals and Systems, Oxford University Press
3. Proakis, J.G.& Manolikis, D.G.: Digital Signal Processing-principles, algorithms and applications, Prentice Hall India

Reference Books:

1. Robert, M. J.: Signals and Systems, Tata McGraw Hill
2. Mitra, S.K.: Digital Signal Processing-a computer based approach, Tata McGraw Hill
3. Xavier, E: Signals, Systems & Signal Processing, S. Chand & Co.
4. Mastering MATLAB, Pearson Education (for Laboratory use)

Course Code	Course Title	Hours per week L-T-P	Credit C
MC181406	Environmental Science	2-0-0	0

MODULE 1: Environment and Ecology

i. Introduction
ii. Environment and Ecology
iii. Objectives of ecological study
iv. Aspects of Ecology
    a) Autecology
    b) Synecology
v. Ecosystem
    a) Structural and functional attributes of an ecosystem
    b) Food chain and food web
    c) Energy flow
    d) Biogeochemical cycles

MODULE 2: Land: Use and Abuse

i. Land use: Impact of land – use on environmental quality
ii. Land degradation
iii. Control of land degradation
iv. Waste land
v. Wet lands

MODULE 3: Water Pollution

a) Introduction
b) Water quality standards
c) Water pollution
d) Control of water pollution
e) Water pollution legislations
f) Water quality management in Rivers

MODULE 4: Air Pollution

i. Introduction
    a) Air pollution system
    b) Air pollutants
ii. Air pollution laws
iii. Control of air pollution
    a) Source correction method
    b) Pollution control equipment

MODULE 5: Noise Pollution

i. Introduction
ii. Sources of noise pollution
iii. Effects of noise
    a) Physical effects
    b) Physiological effects
    c) Psychological effects
iv. controls of Noise pollution

Text / Reference Books:

1. Environmental engineering and management by Dr Suresh Dhameja
2. Environmental studies by Dr B.S. Chauhan
3. Environmental science and engineering by Henry and Hence
4. Environmental studies for undergraduate course by Dr Susmitha Baskar
5. Chemistry for environmental engineering and science by Clair Sawyer

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181412	**Control Systems Lab**	**0-0-2**	**1**

COURSE OBJECTIVES:

1. To enhance the learning experience of the students in topics encountered in Control Systems using MATLAB software
2. To get hands-on experience in using the control system kits which are developed to learn the fundamental concepts of control systems and control system components

COURSE OUTCOMES:

After completion of the course the students will be able to

1. Use MATLAB software to learn control systems (CO1)
2. Analyze the response of control system by measuring relevant parameters (CO2)
3. Interpret the role of various components in control system (CO3)
4. Compare theoretical predictions with experimental results and attempt to resolve any apparent differences (CO4)

Laboratory Course: PART I:

Problems related to theory course on 'Control System' (EI181412) and to be solved using MATLAB software are to be given as assignments.

Laboratory Course: PART II:

LIST OF EXPERIMENTS

1. Light Intensity Control Systems
2. DC Position Control Systems
3. Potentiometer Error Detector
4. Speed-Torque Characteristics of DC Servomotor
5. Synchro-Transmitter Control Transformer pair as an Error Detector

Course Code	Course Title	Hours per week L-T-P	Credit C
IE181414	**Electrical Machines Lab**	**0-0-2**	**1**

Electrical Machines Lab-I

1. O.C.C. of D.C. generators
2. Load Test on D.C. shunt generators
3. Speed Control of D.C. shunt motors
4. Open circuit and short circuit test on single-phase transformers
5. Load test on single-phase transformers
6. Transformer Connections

Electrical Machines Lab-II

1. No-load and blocked-rotor tests on 3-phase induction motors Sumpner's Test or back-to-back test on two similar single-phase transformers
2. Retardation test on a D.C. Machines
3. Hopkinson's or Back-to-back test on two similar D.C. Machines
4. Induction Regulator
5. V-Curves of a synchronous motor
6. Slip-Test on Alternators
7. Synchronization of alternators

Course Code	Course Title	Hours per week L-T-P	Credit C
IE181417	**Instrumentation Lab-II**	**0-0-2**	**1**

LIST OF EXPERIMENTS

1. Study of DC speed control system.
2. Study the characteristics of Inductive pick up
3. Measurement of light intensity by photo resistor.
4. Measurement of speed by proximity sensor.
5. Measurement of water level by capacitive transducer.
6. Measurement of light intensity by photovoltaic cell.
7. Measurement of force/weight by piezoelectric transducer.
8. Study of Stroboscope.
9. Simulation of different probability density functions

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