ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati

Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B.TECH

ELECTRICAL AND ELECTRONICS ENGINEERING

4th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

Course Structure
(From Academic Session 2018-19 onwards)

B.Tech 4th Semester: Electrical and Electronics Engineering
Semester IV/ B.TECH/EEE

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	EEE181401	Electromagnetic Waves	3	1	0	4	30	70
2	EEE181402	Communication Systems	3	0	0	3	30	70
3	EI181402	Control Systems	3	1	0	4	30	70
4	EE181403	Electrical Machines-II	3	1	0	4	30	70
5	EI181401	Electrical Measurements	3	1	0	4	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	EE181413	Electrical Machines-II Lab	0	0	3	1.5	15	35
3	EI181411	Electrical Measurements Lab	0	0	2	1	15	35
TOTAL			17	4	7	**22.5**	**195**	**555**
Total Contact Hours per week: 28								
Total Credit: 22.5								

N.B. 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
EEE181401	**Electromagnetic Waves**	**3-1-0**	**4**

Prerequisites:

- Basic Electrical Engineering

COURSE OBJECTIVES:

To provide exposure to students to the principles governing Electromagnetics, working, radiating systems, waveguides, transmission lines and antenna and the respective applications.

COURSE OUTCOMES:

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

CO1: Students will be able to explain the fundamental concepts of Electromagnetic fields, Maxwell's equation, uniform plane waves in free space and other mediums.
CO2: Students will be able to learn the working of transmission lines and waveguides.
CO3: Students will be able to learn the working principle of waveguides.

MODULE 1: Vector Analysis (5 Lectures)

Review of dot and cross products, gradient, divergence and curl. Divergence and Stoke's Theorem, Cartesian, Cylindrical and Spherical Co-ordinate system. Transformation between coordinates, General curvilinear coordinates. Value of gradient, divergence and curl in general co-ordinates and to obtain their values in cylindrical and spherical coordinates.

MODULE 2: The Static Electric Field (8 Lectures)

Coulomb's law, Electric field strength, Field due to point charges, a line charge and a sheet of charge, Field due to continuous volume charge, Electric flux density, Gauss's law in integral form, Gauss's law in differential form (Maxwell's first equation in electrostatics), Applications of the Gauss's law. Electrostatic potential difference and potential, potential and potential difference expressed as a line integral potential field of a point charge, potential field of a system of charges, conservative property, potential gradient, the dipole, energy density in the electrostatic field.

MODULE 3: The Static Magnetic Field (8 Lectures)

The Biot-Savart's law (the magnetic field of filamentary currents), the magnetic field of distributed surface and volume currents, Ampere's Circuital law in integral and differential form(Maxwell's curl equation for steady magnetic field),The scalar and vector magnetic potentials, Maxwell's divergence equation for B, steady magnetic field laws, forces in magnetic field, force on a current element, force between two current elements, force and torque in the current loop.

MODULE 4: The Electromagnetic Field (10 Lectures)

Faraday's law in integral and differential form (Maxwell's first curl equation for electromagnetic field The Lorentz force equation. The concept of displacement current and modified Ampere's law (Maxwell's 2^{nd} curl equation for electromagnetic field), The continuity equation, power flow in an electromagnetic field, Poynting Vector. Sinusoidally time varying fields, Maxwell's equations for sinusoidally time varying fields, power and energy considerations for sinusoidally time varying fields. The retarded potentials, Polarization of vector fields, review of Maxwell's equations.

MODULE 5: Materials and Fields (review type only) (3 Lectures)
Current and current density, the continuity equation, conductor in fields. Dielectric in fields: Polarization, flux density, electric susceptibility, relative permittivity, Boundary conditions in perfect dielectrics, magnetic materials, magnetization, permeability, boundary conditions.

MODULE 6: Applied Electromagnetics-I (3 Lectures)
Poisson's and Laplace equations, solution of one dimensional cases, general solution of Laplace equation, Method of images.

MODULE 7: Applied Electromagnetics-II (6 Lectures)
Electromagnetic waves, The Helm Holtz equation, wave motion and free space, wave motion in perfect lossy dielectrics, propagation in good conductors, skin effect, Reflection of uniform plane waves. Radiation of electromagnetic waves.

Text Books:

1. Elements of Engineering Electromagnetics – N.N. Rao, Pearson Education
2. Field and Wave Electromagnetics – D.K. Cheng, Pearson Education
3. Electromagnetic Waves & Radiating systems – Jordan & Balmain, TMGH
4. Electromagnetic Field Theory and Transmission Lines- Raju, Pearson Education

Reference Books:

1. Electromagnetics Wave- S.Sadiku

Course Code	Course Title	Hours per week L-T-P	Credit C
EEE181402	**Communication Systems**	**3-0-0**	**3**

COURSE OBJECTIVES

To provide the knowledge of basic principles of communication system, types, design details and applications.

COURSE OUTCOMES (CO)

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

CO1: Express the basic concepts of analog modulation schemes

CO2: Analyze different characteristics of receiver.

CO3: Describe different types of noise and predict its effect on various analog communication systems.

CO4: Understand amplitude and angle modulation and demodulation.

CO5: Understand sampling theorem and pulse modulation systems

MODULE 1: Random Signal Analysis **(4 Lectures)**

Random variables and random processes.

MODULE 2: Amplitude Modulation **(8 Lectures)**

Large Carrier (DSB-LC), Double Sideband Suppressed Carrier (DSB-SC), Single-Sideband (SSB), Vestigial Sideband (VSB). Generation and detection.

MODULE 3: Angle Modulation **(9 Lectures)**

Phase Modulation (PM), Frequency Modulation (FM), Narrowband FM and Wideband FM, frequency division multiplexing (FDM). Generation and detection of PM and FM.

MODULE 4: Radio Receivers **(4 Lectures)**

Super-heterodyne receivers. Image frequency. Image rejection ratio. Receiver sensitivity and selectivity. Phase locked loops. Synchronous detection.

MODULE 5: Noise **(7 Lectures)**

Sources and characteristics of different noise, thermal noise and shot noise, Concept of white Gaussian noise, band-limited white noise, Noise calculations: noise temperature, noise bandwidth and noise figure. Effect of noise on amplitude modulation systems, effect of noise on angle modulation, comparison of different analog communication systems. Envelope detection and threshold effect. Output S/N ratio. Comparison of CW modulation systems.

MODULE 6: Sampling **(6 Lectures)**

Sampling of Analog signal, Quantization of signal, Noise specification, Sampling theorem, practical sampling of PAM, PWM and PPM signals, Nyquist Criterion, Reconstruction Rate.

MODULE 7: Information Source **(5 Lectures)**

Information Sources, Discrete memoryless Sources, Entropy, Information Rate, Channel Capacity, Shannon Theorem.

Text Books:

1. S. Haykin, "*Communication Systems"*, John Wiley & Sons
2. J.G. Proakis and M. Salehi, "*Communication System Engineering"*, Prentice Hall
3. B. P Lathi, "*Modern Digital and Analog Communication Systems",* Oxford University Press

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
EE181403	Electrical Machines-II	3-1-0	4

Course Outcomes:

At the end of the course, the student will be able:

CO1:
To apply the knowledge of electro-magnetic to explain the working of an induction motor.
CO2:
To apply the knowledge of equivalent circuit, basic equations for determination of torque, power and efficiency and to perform laboratory test for determination of motor parameters.
CO3:
To analyze the performance of induction motors based on their control and applications.
CO4:
To have the knowledge of working principles of alternators and their role in electrical power generation Also, they will know about the characteristics of synchronous motors and their applications.
CO5:
To have knowledge of principle of operation of various motors, such as universal motor, repulsion motor, reluctance motor, stepper motor and BLDC motor, and their field of applications.

MODULE 1: Fundamentals of AC Machine Windings (7 Lectures)

Physical arrangement of windings in stator and cylindrical rotor; slots for windings, single turn coil - active portion and overhang, full-pitch and short-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, winding factors. Air-gap MMF distribution with fixed current through - concentrated and distributed and Sinusoidally distributed winding,

MODULE 2: Poly-phase Induction Machines (10 Lectures)

Construction, Types (squirrel cage and slip-ring). Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field. Operating principle of poly-phase induction motors. Torque Slip Characteristics, Starting and Maximum Torque, Equivalent circuit, Phasor Diagram, Losses and Efficiency, Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency), Methods of starting, braking and speed control for induction motors; Generator operation, Self-excitation, Doubly-fed Induction Machines.

MODULE 3: Single-phase Induction Motors (5 Lectures)

Constructional features of single phase induction motor. Magnetic field produced by a single winding - fixed current and alternating current. Double revolving field theory, equivalent circuit, determination of parameters, Split-phase starting methods and applications.

MODULE 4: Synchronous Machines (12 Lectures)

Construction and principles of operation of synchronous generators, emf equation. Armature reaction, leakage reactance, synchronous reactance, and impendence of non-salient pole machines. Short circuit and open circuit tests, short circuit ratio, M M F in salient and non-salient pole machines. Calculation of regulation by synchronous impedance method. MMF method and ASA method.

Introduction to two-reactance theory, locus diagram of synchronous impedance, slip test, damper winding and oscillation of synchronous machines, Synchronization, power angle diagram and synchronizing power. Sub-transient and transient reactance of synchronous machine. Parallel operation and load sharing of synchronous machines.

Construction and principles of operation of synchronous motor. Phasor diagram, effect of varying excitation, effect of load variation, V-curve, O-curve, power angle diagram and stability, Hunting, Two-reaction theory of salient-pole motor, Starting. Use as synchronous phase modifiers.

MODULE 5: Other Motors **(6 Lectures)**

1-Phase Commutator Motors: Universal and repulsion motors: Construction and principle of operation, Starting methods, Speed control, Improvement of commutation and power-factor by compensation.

Reluctance Motors (Conventional and Switched): Construction and principle of operation, Speed-torque characteristic.

Stepper Motor: Construction and principle of operation, types, characteristics. Selection and Application.

Brush-less DC motor (BLDC): Construction and principle of operation, types and applications.

Text Books:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery, McGraw Hill Education, 2013.
2. P. S. Bimbhra, –Electrical Machinery‖, Khanna Publishers, 2011.
3. M. N. Bandopadhyay, –Electrical Machines: Theory and Practice‖, PHI

Reference Books:

1. M. G. Say, –Performance and design of AC machines‖, CBS Publishers, 2002.
2. I.J. Nagrath and D. P. Kothari, ―Electric Machines‖, McGraw Hill Education, 2010.
3. A. S. Langsdorf, –Alternating current machines‖, McGraw Hill Education, 1984.
4. P. C. Sen, –Principles of Electric Machines and Power Electronics‖, John Wiley & Sons, 2007.
5. B. L. Theraja, A. K. Theraja, –A Text Book of Electrical Technology Vol II A.C. and D.C. Machines‖, S. Chand & Co., 2015.

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
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
EE181413	**Electrical Machines-II Lab**	**0-0-3**	**1.5**

Course Objectives:

The Electrical Machines-I Laboratory is designed to provide the students with the practical knowledge of electrical machines specifically keeping in view the following objectives:

1. to get hands-on experience in performing the basic tests on electrical machines
2. to reinforce the theoretical concepts with related practical understanding
3. to know about the various precautionary measures necessary in handling electrical machines

Course Outcome:
After completing this course, the students will
CO1:
be familiar with the mode of starting, switching-off, and taking precautionary measures while handling electrical machines
CO2:
be able to reinforce their theoretical concepts by way of experimentation
CO2:
develop report writing skill

LIST OF EXPERIMENTS

1. Retardation test on a D.C. Machine
2. No-load test and blocked-rotor test on 3-phase induction motor
3. Working of Single phase and three-phase Induction Regulator
4. V-Curves of a synchronous motor
5. Slip-Test on Alternator
6. Regulation of alternator by synchronous impedance and MMF method
7. Measurement of real and reactive power of induction generator
8. Synchronization of alternators

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181411	Electrical Measurements Lab	0-0-2	1

Course Objectives:
The Electrical Measurement Lab gives idea about how to visualize and work in laboratory environment and how to work in a team. Students understand the applications of various A.C and D.C Bridge in practical Electrical and Instrumentation Engineering field. Students learn about how to measure resistance, Inductance, Capacitance, Voltage, Current, Power, Power Factor and Electrical Energy using different experiments in the Lab.

Course Outcomes (CO)
After completing this course
1. Student will be able to measure the resistance, inductance and capacitance using DC and AC bridges.
2. Student will be able to calibrate and test single phase energy meter and to measure 3-phase active power with balanced 3-phase R-L load.
3. Student will be able to calibrate and test single phase current and potential transformers and measures the core loss in magnetic circuit.

LIST OF EXPERIMENTS

1. To Measure the Low Resistance of a Wire or Rod Using Student Kelvin Double Bridge
2. To Measure the inductance of a given coil by Anderson Bridge method
3. To Measure Unknown Inductance and Capacitance by Maxwell's L/C Bridge
4. To Measure unknown value of Capacitance using Wien Bridge
5. To Measure the Value of unknown Capacitance by Schering Bridge
6. Calibration of single phase energy meter with resistive load To Measure 3-phase Power by Two Wattmeter Method
7. To Measure 3-phase Power by Two Wattmeter Method
8. Study of CT and PT
9. Lissajous Pattern using CRO
10. Temperature measurement using RTD
11. Temperature measurement using Thermistor
12. Temperature measurement using Thermocouple

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