ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B.TECH
ELECTRICAL ENGINEERING

3rd SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

Course Structure
(From Academic Session 2018-19 onwards)

B.Tech 3rd Semester: Electrical Engineering

Semester III/ B. TECH/EE

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	MA181301A	Mathematics III-A (for branches other than CSE and ECE/ETE)	2	1	0	3	30	70
2	EI181302	Electrical Circuit Analysis	3	1	0	4	30	70
3	EI181303	Analog Electronics	3	0	0	3	30	70
4	EI181304	Electrical Machines-I	3	1	0	4	30	70
5	EI181305	Digital Electronics	3	0	0	3	30	70
6	MC181306	Constitution of India	2	0	0	0 (PP/NP)	-	100
Practical								
1	EI181313	Analog Electronics Lab	0	0	2	1	15	35
2	EI181314	Electrical Machines-I Lab	0	0	3	1.5	15	35
3	EI181315	Digital Electronics Lab	0	0	2	1	15	35
4	SI181321	Internship-I (SAI - Social)	0	0	0	1	-	100
TOTAL			16	3	7	**21.5**	**195**	**655**
Total Contact Hours per week : 26								
Total Credits: 21.5								

N.B. MC181306 is a Mandatory Audit Course (No Credit). It will be evaluated as PP (Pass) or NP (Not Pass)

Detailed Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
MA181301A	**Mathematics III-A** (for branches other than CSE and ECE/ETE)	**2-1-0**	**3**

MODULE 1: Partial Differential Equation: (15 Hours)
Formation of Partial Differential equations, Linear partial differential equation of first order, Non-linear partial differential equations of first order, Charpit's method, Method of separation of variables, boundary value problem with reference to the one dimensional heat and wave equation.

MODULE 2: Probability Theory: (15 Hours)
Review of basic probability and Bayes' theorem, Probability distribution, Binomial, Poisson and normal distribution, Joint distribution, Test of significance, fitting of straight line by least square method, Elementary concept of Markov Chain.

MODULE 3: Laplace Transform: (10 Hours)
Laplace transform of elementary function, Properties of Laplace transform, inverse Laplace transform, convolution theorem, Solution of ordinary differential equations with the help of Laplace transform.

Textbooks/References:

1. Advanced Engineering Mathematics: Erwin Kreyszig
2. Higher Engineering Mathematics: B V Ramana
3. Theory and problems of Probability: Seymour Lipschutz
4. A text book of engineering Mathematics: N. P. Bali & M. Goel
5. Statistical Methods: An Introductory Text- J.Medhi, New Age International Publishers

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181302	**Electrical Circuit Analysis**	**3-1-0**	**4**

Pre-requisite: Knowledge of basic electrical engineering

Course Objectives:

- To impart the basic knowledge about various elements of electric circuits.
- To inculcate the understanding about application of Network Theorems for solving circuits and modelling circuits using matrix representation.
- To understand network topology, transient phenomenon and two port networks.
- To be able to apply various techniques of networks synthesis from network functions.

Course Outcomes:

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

CO1:
Apply appropriate laws of various circuit elements to develop mathematical models, detailing their constructional features and their applications.

CO2:
Make use of various network theorems to evaluate variety of networks and to model given networks using appropriate matrix representation amenable to various types of network analysis.

CO3:
Model networks using elementary graph theory and to analyse given networks for their transient response.

CO4:
Utilize the concept of two port networks, their characteristics and mode of interconnection to evaluate various networks.

CO5: Synthesize networks from various network functions like admittance and impedance functions.

MODULE 1: Elements of electric circuits: (5 Lectures)
resistor: Practical engineering devices. Solid & wire frame of common resistive materials, carbon film and metal film resistors. Heat dissipating area (wattage), tolerance and temperature stability of resistors. Mathematical models, the capacitor: Comparison of properties of different traditional & modern dielectric materials (e.g. paper, ceramic, polystyrene polycarbonates etc.) Short description of electrolytic capacitor- wet & solid dielectrics, solid tantalum & aluminium capacitors, Mathematical models, the inductors: Mutual inductance, Properties of core materials.

Brief studies of iron & ferrite cores, Mathematical models (only assignments).

MODULE 2: Network theorems: (8 Lectures)
Millman's theorem, Reciprocity theorem, Compensation & Tellegen's, etc. Analysis of coupled circuits. The dot rule & equivalent conductivity coupled forms of magnetically coupled circuits.

MODULE 3: Methods for the solution of circuit equations: (4 Lectures)
Analysis of electrical network with – independent/dependent ideal, practical current voltage and current sources – both of DC and AC. Solution of network equations by matrix methods.

MODULE 4: Network topology: (5 Lectures)
Elementary graph theory as applied to electrical networks. Matrices of graph: Incidence matrix, circuit matrix, cut set matrix. Advanced techniques of equation formulation for numerical solutions.

MODULE 5: Transient phenomenon: (7 Lectures)
Forcing functions-impulse, step and ramp functions Study and solution of simple circuits undergoing transient disturbances, A.C. transients, Time domain equations and solutions by Laplace transforms

MODULE 6: Two port Network: (7 Lectures)
General principles, ABCD, Z, Y and hybrid parameters, Analysis of networks in tandem. Transmission lines. Lumped and distributed models. Combination/Interconnection of two ports network.

MODULE 7: Introduction to Network Synthesis: (9 Lectures)
Realizability of networks, positive real function (PRF) and its properties, Hurwitz polynomial, Routh-Hurwitz Array, properties of various immittance functions (LC, RC, RL), Foster and Caur forms of realization of network for given driving point impedance/admittance function.

Text Books:

1. Basic Electrical Engineering—A Chakravarti, S Nath, C K Chanda, Tata Mcgrawhill, 2017
2. Network Analysis and Synthesis—Smarajit Ghosh,PHI, First Edition
3. Electric Circuit----J.A. Edminiter. (Mcgraw hill)
4. Networks and Systems ---D Roychowdhury, New Age International Publications, 1998
5. A course in Electric Circuit Analysis—Soni & Gupta

Reference Books:

1. Computer aided Network Design—Donald A. Calahan (Tata Mcgraw hill)
2. Engineering Circuit analysis---- W. H. Hayt Jr. & J.E. Kemmerly (Mcgraw hill)
3. Network Analysis---M E Van Valkenburg, PHI, 2006
4. Electric Circuits----C K Alexander and M N O Sadiku, McGraw Hill Education ,2004

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181303	**Analog Electronics**	**3-0-0**	**3**

Course Objectives:

- To teach the basic concept and applications of various analog electronic devices and circuits.
- To develop problem formulation and problem solving ability amongst the students.

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

CO1:
Identify and analyze various types of diodes and their applications.

CO2:
Characterize and analyze the performance and applications of BJTs and FETs.

CO3:
Analyze the performance of cascaded amplifiers.

CO4:
Analyze the effects of Negative and Positive Feedback on amplifiers.

CO5:
Analyze and design basic OPAMP applications.

MODULE 1: The P-N Junction: (8 Lectures)
Charge Flow Description and Energy Band Description of P-N Junction. Shockley's Equation. Resistance and Capacitances associated with a P-N Junction. Piecewise linear model of Diode. Effect of temperature.

Practical applications of diodes, Rectifiers and Filters, Clippers, Clampers, Voltage Multipliers.

Special Purpose Diodes- Zener Diode, LED, Photo-Diode, Varactor Diode, Tunnel Diode, Schottky Diode.

MODULE 2: Bipolar Junction Transistor: (12 Lectures)
Construction and Principle of operation of BJT. Transistor Action. Transistor Current Equations, 'α' and 'β' parameters. Transistor Characteristics. Early Effect. Ebers-Moll Model and Justification of Transistor Characteristics. Concept of Amplification and Switching Action.
Transistor Biasing Circuits. Stability of operation and Stability Factor

Small signal r_e-parameter model and h-parameter model of the BJT. Introduction to π- model. Analysis of amplifiers with small signal models. Current Gain, Voltage Gain, Power Gain, Input Impedance and Output Impedance. Introduction to Miller's Theorem. Cascaded Amplifier. Coupling between stages, Frequency Response and Band Width of an amplifier.
Darlington Connection, Cascode Connection and Difference Amplifier Connection of Transistors.

MODULE 3: Field Effect transistors, JFET and MOSFET: (5 Lectures)

Basic construction and physical behaviour of JFET and MOSFET. Study of current flow through JFET and MOSFET. JFET and MOSFET Characteristics- Drain Characteristics and Transfer Characteristics. Biasing circuits for JFET and MOSFET. Small Signal Model of JFET. Analysis of JFET amplifier.

JFET and MOSFET switches.

MODULE 4: Effect of Negative and Positive Feedback in Amplifiers: (5 Lectures)

Effect of Negative Feedback in amplifiers and its advantages. Analysis of different feedback configurations.

Positive Feedback. Bark Hausen Criteria for oscillation. Analysis of RC Oscillator, LC Oscillator and Crystal Oscillator.

MODULE 5: Integrated Circuit Electronics: (10 Lectures)

Internal Circuit Diagram of OPAMPs, TTL Gates and CMOS Gates.

Functional Block Diagram and Ideal Characteristics of OPAMP, Open-Loop Gain, Input and Output Impedance, Bandwidth, CMRR, Slew Rate, Input Offset Voltage and Current.

Closed Loop application of OPAMP, - Non-Inverting and Inverting Configurations. Concept of Virtual Ground. Non-inverting and Inverting Amplifiers. Adders, Subtractors, Difference Amplifiers and Instrumentation Amplifier. Integrators and Differentiators. Log Amplifier. OPAMP Sinusoidal Oscillators.

Non-Linear Applications – Comparator, Schmitt trigger, Zero Crossing Detector, A stable Multivibrator.

Active Filters, LPF, HPF, BPF and Notch Filters.

Introduction to Timer IC 555 and it' s applications.

Textbooks/References:

1. Integrated Electronics - Millman & Halkias (PHI).
2. OPAMPS and Linear Integrated Circuits- Ramakant A. Gayakwad (PHI)
3. Electronic Devices and Circuits – David J Bell. (Oxford)

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181304	**Electrical Machines-I**	**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 transformers

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

CO1:
Understand the principles of electromagnetic energy conversion and electromagnetic induction
CO2:
Understand the principles of operation and construction of D.C. machines (both motors and generators) and transformers
CO3:
Analyze the various characteristics of D.C. generators and D.C. motors, and various connections of three-phase transformers
CO4:
Interpret the necessary conditions to be satisfied for parallel operation of D.C. Generators and single phase and three phase transformers
CO5:
Evaluate the performances of DC machines and transformers by carrying out various tests on them

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

Review of magnetic circuits, MMF, Electromagnetic induction, magnetically induced e.m.f., Magnetically coupled circuits

Basic principles of energy conversion, Field magnets, Dynamically induced e.m.f. and torque in rotating machines

MODULE 2: D.C. Machines

(i) Generators: (12 Lectures)

Constructional features, Details of Armature windings, Methods of excitations-shunt, series and compound. E M F equation, Armature reaction, Inter-poles and compensatory windings, Commutation, Characteristic of generators, Efficiency and Regulation, Parallel operation

(ii) Motors: (8 Lectures)

Torque equation of motors, Speed and Torque characteristic curves of shunt, series and compound motors, Starting of D C motors – Starters and grading of starting resistance, Speed control-

conventional methods and solid state control, Choice of motors for different duties, Losses and efficiency, Testing – Swinburne's test, Back to back test, Retardation test and Brake test.

MODULE 3: Transformers: (8 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 and output equation, Magnetic circuit, leakage flux and leakage reactance, Phasor diagram, per unit values of resistance and reactance, Open circuit and short tests, back to back test, Regulation, losses and efficiency, maximum efficiency, all-day efficiency, Auto-transfer, 3-phase transformer, Phase transformation and connections. Parallel operation of transformers, Vector grouping, Harmonics.

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
EI181305	**Digital Electronics**	**3-0-0**	**3**

Prerequisites: Basic idea of Electrical and electronics circuits

Course Objectives:

- To understand number representation and conversion between different representation in digital electronic circuits.
- To understand and implement logical operations using combinational logic circuits.
- To understand and implement logical operations using sequential logic circuits.
- To understand characteristics of memory and their classification.

Course Outcomes:

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

CO1: Perform conversion of n-bit codes from one form to another form.

CO2: Design a logical circuit using the minimum number of gates for a given logical expression.

CO3: Use and demonstrate a given digital combinational circuit.

CO4: Use different types of flip-flops and design a sequential logic circuit.

CO5: Design ROM, RAM and PLA for a given application.

MODULE 1: Number system (4 Lectures)

Representation of Binary numbers, octal and hexadecimal numbers, complements, signed binary numbers, Binary codes, code conversion, floating point numbers and arithmetic and the conversion process.

MODULE 2: Boolean algebra and logic gates (4 Lectures)

Basic theorems and properties of Boolean algebra, Boolean functions, canonical and standard forms-SOP & POS. Logical operations, truth tables, logic gates, logic levels and pulse waveforms.

MODULE 3: Simplification of Boolean functions (6 Lectures)

The map method- the Karnaugh map, minimal SOP & POS, Don't care conditions, multiple output minimization, tabular method, Quine-Mcclusky method, determination and selection of prime implicants.

MODULE 4: Combinational Logic circuits (9 Lectures)

Introduction: Logic synthesis: Introduction, universal property of NAND and NOR gates, AND-OR networks, NAND & NOR networks, EX-OR networks.

Adders & substractors, parallel binary adders, magnitude comparator, decoders & encoders, Multiplexer & demultiplexers, parity generators & checkers. ROM, RAM and PLA.

MODULE 5: Sequential Logic Circuits **(9 Lectures)**

S-R, J-K, D and T Flip Flops, Excitation table, Triggering of FFs & Latches, one shot A stable Multivibrator. Registers: - Shift – Registers, Ripple Counters, Synchronous Counters. Ring Counters, Timing Sequences, Design Procedure.

MODULE 6: Digital integrated Circuit **(4 Lectures)**

Introduction, special characteristics (Fan-Out, Power dissipation, Propagation delay, figure of merit, noise level) Introduction to TTL, ECL, MOS, and CMOS circuit.

MODULE 7: A/D and D/A converters **(4 Lectures)**

Introduction and examples of ADC and DAC circuits.

Text Books:

1. Digital Design – M. Marris Mano.
2. Logic Design Theory – NN Biswas
3. Digital Fundamental – TL Floyd
4. Digital Electronics- R. P. Jain.

Reference Books:

1. Logic Design Theory – NN Biswas
2. Digital Fundamental – TL Floyd

Course Code	Course Title	Hours per week L-T-P	Credit C
MC181306	**Constitution of India**	**2-0-0**	**0 (PP/NP)**

Course Objectives: Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

MODULE 1: History of Making of the Indian Constitution:

a) History
b) Drafting Committee, (Composition & Working)

MODULE 2: Philosophy of the Indian Constitution:

a) Preamble
b) Salient Features

MODULE 3: Contours of Constitutional Rights & Duties:

a) Fundamental Rights
b) Right to Equality
c) Right to Freedom
d) Right against Exploitation
e) Right to Freedom of Religion
f) Cultural and Educational Rights
g) Right to Constitutional Remedies □ Directive Principles of State Policy □ Fundamental Duties.

MODULE 4: Organs of Governance:

a) Parliament
b) Composition
c) Qualifications and Disqualifications
d) Powers and Functions
e) Executive
f) President
g) Governor
h) Council of Ministers
i) Judiciary, Appointment and Transfer of Judges, Qualifications
j) Powers and Functions

MODULE 5: Local Administration:

a) District's Administration head: Role and Importance,
b) Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation.
c) Pachayati raj: Introduction, PRI: Zila Pachayat.
d) Elected officials and their roles, CEO Zila Pachayat: Position and role.
e) Block level: Organizational Hierarchy (Different departments),
f) Village level: Role of Elected and Appointed officials,
g) Importance of grass root democracy

MODULE 6: Election Commission:

a) Election Commission: Role and Functioning.
b) Chief Election Commissioner and Election Commissioners.
c) State Election Commission: Role and Functioning.
d) Institute and Bodies for the welfare of SC/ST/OBC and women.

Textbooks/References:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181313	**Analog Electronics Lab**	**0-0-2**	**1**

Course Objectives:

1. To understand the basic concept of various electronic devices, circuits and their application.
2. To develop ability among students to design and implement electronic circuits.

Course Outcomes:

After completing this course, the students will be able

1. To determine the dc and ac parameters of semiconductor devices.
2. To analyze the performance of different types of rectifier with and without filter.
3. To plot frequency response of BJT and JFET amplifier.
4. To analyze effect of negative and positive feedback on the performance of amplifier.

LIST OF EXPERIMENTS

1. Study of Rectifier and Filter
2. Common Base Characteristics and Evaluation of H-Parameters.
3. Common Emitter Characteristics and Evaluation of H- Parameters.
4. Study of R-C Coupled Common Emitter Amplifier and Effect of Feedback.
5. Study of JFET Characteristics and Common Source Amplifier.
6. Study of OPAMP Inverting and Non-Inverting Amplifiers.
7. Study of OPAMP Summing and Difference Amplifiers and Instrumentation Amplifier.
8. Study of OPAMP Phase-Shift Oscillator and Wien Bridge Oscillator.
9. Study of OPAMP Active Filters.
10. Study of Non-Linear Opamp Applications.

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181314	**Electrical Machines-I 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
4. to develop technical report writing skill

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

CO3:
develop report writing skill

LIST OF EXPERIMENTS

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. Sumpner's Test or back-to-back test on two similar single-phase transformers
7. Three-phase Transformer Connections
8. Hopkinson's or Back-to-back test on two similar D.C. Machines

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181315	**Digital Electronics Lab**	**0-0-2**	**1**

Course outcomes:

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

CO1:
verify and analyze the outputs of combinational logic circuits and relate theoretical concepts with experimental analysis.
CO2:
verify and analyze the outputs of sequential logic circuits and relate theoretical concepts with experimental analysis.
CO3:
organize and write an engineering report after performing an experiment on digital circuits.

LIST OF EXPERIMENTS

1. Realization of basic gates by using universal gates
2. Realization of XOR gate
3. Combinational Logic Design using 74xx ICs
4. Arithmetic Circuit- construction and testing using 74xxICs: Half/Full Adder
5. Construction of 1- bit comparator using 74xxICs.
6. code converters – Binary to Gray & Gray to binary.
7. Verification of Truth Table of SR Flip-Flop
8. Verification of Truth Tables of JK, D, T Flip-Flops
9. 3-Bit synchronous counter design
10. Decade Counter design

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ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati

Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B.TECH

ELECTRICAL ENGINEERING

4th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

Course Structure
(From Academic Session 2018-19 onwards)

B.Tech 4th Semester: Electrical Engineering
Semester IV/ B.TECH/EE

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	EE181403	Electrical Machines-II	3	1	0	4	30	70
4	EE181404	Power System-I	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	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
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
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
EE181404	**Power System-I**	**3-1-0**	**4**

Prerequisites:

- Basic Electrical Engineering

COURSE OBJECTIVES:

1. To impart knowledge on the basic structure of power system and mechanical/electrical design of overhead lines.
2. To familiarize different types of tower structure and environmental effects on sag calculation.
3. To understand various aspects of underground cables and their increasing uses in power system.
4. To give an idea about the fundamental concepts of electrical power distribution, both AC & DC

COURSE OUTCOMES:

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

CO1: Students will be able to articulate the basics of power system and relate theoretical concepts in engineering problems.

CO2: Students will be able to analyse the performance of transmission lines and its parameters.

CO3: Students will be able to classify different types of insulators and design an environmentally safe supporting structure of transmission line by computing sag and ground clearance given the terrain in which transmission is to be provided.

CO4: Students will be able to apply knowledge with justification in technical issues involved during selection and laying of underground cables.

CO5: Students will be able to classify different types of AC and DC distribution systems.

MODULE 1: General Introduction (2 Lectures)

Basic structure of power system: Generation, transmission and distributions. Various levels of power transmission and basic layout arrangement of an inter-connected power system network.

MODULE 2: Transmission Line Parameters (8 Lectures)

Conductor materials, Types of conductors- ACSR, expanded ACSR, Stranded, bundle and composite conductors; Use of standard wire tables. Current distortion Effect-Skin effect and proximity effect.

Inductance of a 1-phase system with composite conductors; Inductance and capacitance of 1-ph & 3-ph single circuit and double circuit transmission lines with symmetrical and unsymmetrical spacing; Transposition; Concept of G.M.D. Effect of earth in 1-ph and 3-ph lines; Charging current.

MODULE 3: Performance of Transmission Lines (8 Lectures)

Classification of transmission lines- short, medium and long lines: Nominal- T and Nominal- pi representation of medium line. Analysis of long transmission line (Rigorous method). Regulation & efficiency; Generalised Network Constants of a transmission line. Evaluation of ABCD constants from mathematical models (short & medium); SIL, Ferranti effect.

MODULE 4: Mechanical Design (10 Lectures)

(a) Line support: Supporting structure for overhead lines, Towers
(b) Insulators: Types of insulators; Voltage distribution on an insulator string; Stringing efficiency; Methods of grading of insulators and static shielding; Testing of insulators.
(c) Sag: Calculation of sag & tension – effect of wind and ice loading; Support at different levels; Spacing between conductors.
Introduction: Stringing chart, Sag template, Vibration and Vibration damper, Conductor spacing and ground clearance.
(d) Corona: Electric stress at surface of overhead line conductors; Disruptive critical voltage; Visual critical voltage; Corona loss; Factors effecting corona loss; Method of reducing loss; Radio interference – electrostatic and electromagnetic interference with communication lines.

MODULE 5: Underground Cable (7 Lectures)

Different types of underground cables; Insulating materials; Insulation resistance; Breakdown of cable insulation; High voltage cables – Internal & external gas pressure cables, Gas filled cables; Capacitance of single and multi-core cables; Grading of cables; Insulation; Sheath losses; Dielectric losses; Thermal ratings; Testing of cables; Method of cable laying and cable joining; Maximum current carrying capacity of cables.

MODULE 6: Distribution (5 Lectures)

Classification of distribution system-AC & DC; Design consideration in a distribution system; Scheme of connection- Radial, Ring, Interconnected DC distribution, stepped distributors Concentrated and distributed loads in radial distributors fed at one and both ends. Ring distributor with interconnector.

Text Books:

1. Electrical Power Transmission and Distribution – S. Sivanagaraju, S. Satyanarayana
2. Electrical Power System---C. L. Wadha.
3. Principle of power system—V.K. Mehta, Rohit Mehta
4. A course in Power System- J. B. Gupta
5. Electrical Power Delivery Systems- R. Jayashri…

Reference Books:

1. Power System Engineering- Nagrath and Kothari
2. Switchgear and Protection—S.S. Rao
3. Switchgear and Protection-- M.V. Despande.
4. Electrical Power—S. L. Uppal.
5. Electrical Power System's design—M.V. Despande.

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
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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ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B.TECH
ELECTRICAL ENGINEERING

5th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure

(From Academic Session 2018-19 onwards)

B.Tech 5th Semester
Semester V/B. TECH/Electrical Engineering/EE

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	EI181501	Power System-II	3	1	0	4	30	70
2	EI181502	Power Electronics	3	0	0	3	30	70
3	EI181503	Microprocessors	3	0	0	3	30	70
4	EI1815PE1*	Program Elective-1	3	0	0	3	30	70
5	EI1815OE1*	Open Elective-1	3	0	0	3	30	70
6	HS181506	Engineering Economics	3	0	0	3	30	70
Practical								
1	EI181512	Power Electronics Lab	0	0	2	1	15	35
2	EI181513	Microprocessors Lab	0	0	2	1	15	35
3	SI181521	Internship-II (SAI – Academia)	0	0	0	1	-	100
TOTAL			18	1	4	**22**	**210**	**590**
Total Contact Hours per week: 23								
Total Credits: 22								

PROGRAMME ELECTIVE-1 SUBJECTS

Sl No.	Subject Code	Subject
1	EI1815PE11	Advanced Control System
2	EI1815PE12	Advanced Electrical Measurements
3	EI1815PE13	Computer Organization
4	EI1815PE14	Electrical System Design and Drawing
5	EI1815PE15	Electronic System Design
6	EI1815PE1*	Any other subject offered from time to time with the approval of the University

OPEN ELECTIVE-1 SUBJECTS

Sl No.	Subject Code	Subject
1	EI1815OE11	Data Structures and Algorithms Basics
2	EI1815OE12	Computer Oriented Numerical Methods
3	EI1815OE13	Digital Signal Processing
4	EI1815OE1*	Any other subject offered from time to time with the approval of the University

Detailed Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181501	**Power System-II**	**3-1-0**	**4**

Course Objectives:

This course is developed for the purpose of providing detailed knowledge about power system operational planning using computational methods. In a power system, it is not allowed to carry out experiments related to operational planning of the system. Therefore, simulation based analytical methods are used for planning and operation of a powers system related to Fault analysis, load flow analysis, topology detection, Steady state, dynamic and Transient stability analysis etc. Fundamentals of power system network analysis using bus matrix concept has been incorporated in the course. The categories of fault analysis, such as symmetrical and unsymmetrical fault analysis methods involving symmetrical component concept has been highlighted in the course. Load flow analysis is dealt using GS, and NR methods. Power system slow and fast dynamic analysis such as transient stability analysis, using equal area criterion and numerical solution of power swing equation under transient contingency condition are introduced in the course. This course also introduces the concept of neutral grounding and overvoltage phenomenon in power systems.

COURSE OUTCOMES:

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

CO1: To define the basic idea of power system network representation for analysis of an interconnected power system.

CO2: To apply the concept of power system fault analysis in power system planning and operation.

CO3: To define load flow analysis and to apply it in power system operation and planning

CO4: To define he basic concept of power system stability and its application in the understating the stability condition under transient and dynamic condition of a power system.

CO5. To understand the concept of neutral grounding and overvoltage phenomenon I power system operation.

MODULE 1: Power System Economics (4 Lectures)

Economics of power plants, load curves, load factors, diversity factors; Utilization factor, Tariffs and Tariff structure, Economics of power factor improvement, Definitions and Characteristics of Base load and Peak load plant.

MODULE 2: Symmetrical Components and Unsymmetrical Fault Calculations (6 Lectures)

Fortesque's theorem. Symmetrical components of an unbalanced 3- phase system: average power in terms of symmetrical components, sequence impedances, fault calculations, graphical method for determining sequence components, network equations. LG, LL, LLG faults. Effect of fault impedance on fault current. Sequence networks.

MODULE 3: Neutral Grounding (4 Lectures)

Effectively grounded system. Ungrounded system. Arcing ground. Methods of neutral grounding. Resistance, Reactance and Resonant grounding (Peterson coil) Earthing Transformers. Equipment grounding. Generator neutral Breaker

MODULE 4: Representation of Power System Components and Network Matrix (6 Lectures)
***Per Unit Representation of power system elements such as*:** Synchronous machine, transformers with tap setting, transmission line etc. Single line diagram. Problem Solving.

***Network matrix*:** Primitive network, bus incidence matrix, formation of Y-bus by singular transformation , networks with mutually coupled elements, formation of Z-bus by matrix inversion , formation of Z-bus using the building algorithm – addition of a tree branch p to reference bus , addition of a link between buses p and q , addition of a link between bus p and reference bus.

MODULE 5: Load Flow Analysis (10 Lectures)
Introduction, classification of buses, representation of transformers, Gauss Seidel iterative method using Y-bus, N-R iterative method using Y-bus. Calculation of line flows.

MODULE 6: Power System Stability (10 Lectures)
Introduction. Dynamics of synchronous machine, Swing equation. Power-angle curve. Steady- state and transient stabilities. Equal area criterion. Calculation of power-angle curves for fault and post fault conditions for various types of fault, effect of reclosing. Numerical solution of swing equation. Dynamic Stability. Factors affecting stability.

Textbooks/Reference Books:

1. Electrical Power—S.L.Uppal.
2. Electrical Power System---C.L.Wadha.
3. Computer Methods in Power System Analysis – Stagg, El-abiad McGraw-Hill
4. Power system operation and Control – P S Murty Tata McGRAW-Hill
5. Computer Techniques in Power System Analysis: M A Pai, Tata McGRAW HILL
6. Power System Analysis: I J Nagrath and D P Kothari, Tata McGRAW HILL

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181502	**Power Electronics**	**3-0-0**	**3**

Prerequisites:
Knowledge of basic electrical and electronics engineering

COURSE OBJECTIVES:
To understand the principle of operation of SCR, GTO devices etc.
To know about triggering, commutation of SCR, firing circuits, commutation circuits etc.
To understand various connections of thyristors, protection etc.
To understand operation of various converters. UPS etc.
To know principle of operation of chopper, inverter, their voltage control etc.

COURSE OUTCOMES:
At the end of the course, the students will be able to
CO1: Use various switching devices such as SCR, GTO, etc for power electronic applications.
CO2: Justify use of various regulators, UPS circuits, their working, SMPS etc.
CO3: Derive in-depth knowledge about single phase and three phase converters, AC regulators, cyclo-converters, dual-converters etc.
CO4: Examine working of various inverters and choppers, their output voltage control methods, specific inverters and choppers and their applications.
CO5: Assess use of Battery Chargers, replacement of electro-mechanical devices by SCRs.

MODULE 1: Semiconductor Power Devices (10 Lectures)
Introduction, power diodes, power transistors (BJT, MOFET, IGBT, ICT etc) and SCRs and their operations, GTOs, Triacs and other types of thyristors, their characteristics, ratings, mounting and cooling. Series and parallel connections of SCRs. Triggering and control.

MODULE 2: Regulated Power Supplies (5 Lectures)
Requirements and principles Constant voltage and current regulators, use of ICs, Line regulation, introduction to switching regulators. Switching mode power supply, UPS – ON-line and OFF-LINE types,

MODULE 3: Converter Operation with SCRs (10 Lectures)
Single phase half- wave, full- wave and bridge circuits, three- phase half wave and bridge circuits, six-phase with interphase transformer, fully controlled and half- controlled circuits. Effects of load and source inductance. AC controller – single phase and three phase, half control and full control, applications of ac controllers. Dual converter and cycloconverter operating modes. Line commuted inverters, firing and control circuits for different operations.

MODULE 4: Forward Commutation and Forced Commutated Inverters (8 Lectures)
Forced commutation circuits, parallel, series and bridge (single- phase and three- phase) inverters, McMurray and McMurray- Bedford inverter circuits, Voltage and current source inverters. Output voltage control harmonics eliminations. Firing circuits for inverters.

MODULE 5: Choppers **(8 Lectures)**

Principles of operation, classification, Time Ratio control & Current Limit Control, DC, AC, and multi-quadrant choppers, Heumann's (voltage commutated), Morgan's, Jone's, and Mazda's choppers. Applications.

MODULE 6: Application of SCRs **(4 Lectures)**

SCR battery chargers, replacement of electromechanical devices by SCRs

Textbooks:

1. P. S. Bimbhra, ―Power Electronics, Khanna Publishers
2. M. D Singh, K B Khanchandani—Power Electronics, Tata McGraw Hill Publishing
3. C. W. Lander, ―Power Electronics, McGraw-Hill Publication
4. Jamil Asghar M. Syed, ―Power Electronics, PHI

Reference Books:

1. 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. Gray, P.E. &c.L.Scurle: Electronic Principles- Wiley Eastern.
6. Ramamurthy, m.: An Introduction to Thrusters and their Applications- East West Press.

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181503	**Microprocessors**	**3-0-0**	**3**

Prerequisites:

- Analogue Electronics, Digital Electronics.

COURSE OUTCOMES:

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

CO1: To define the basic concept of programmable device and structural arrangement of 8085 and its instructions.

CO2: Develop the general idea for interfacing memory devices and I/O devices to ensure unique address for each device.

CO3: To develop the basic concepts of PPIs and their operational concepts, and apply this knowledge in different engineering applications.

CO4: Develop assembly and machine language microprocessor programs for utilization in societal, academic and industrial purposes.

CO5: To demonstrate the basic evolutionary process leading to the development of microprocessor-based system for a few practical applications.

MODULE 1: Microprocessor Architecture (6 Lectures)

Introduction to the microprocessor- Introduction to tri-state device- register, ALU, counter etc. Basic concepts of programmable device – Bus organization, system components etc. Block diagram of μP 0885- data bus, address bus, timing and control section, registers, etc

MODULE 2: Interfacing Memory Devices and I/O devices (4 Lectures)

System BUS representation, Address space and its portioning; address decoding, memory and I/O mapping and management.

MODULE 3: Programming Microprocessors (12 Lectures)

Data representation, instruction formats, addressing modes, Instruction set, software design, assembly language programming, program looping, subroutine linkage - uses of stack and stack pointer, push pop operation etc. Assembly and code language programming with examples, timing diagram of instructions

MODULE 4: Support PPIs (12 Lectures)

PPIs - 8255, 8253 and 8279; their functional block diagram, operational modes and configuration of the device in different mode of operations, assembly language program for using the PPIs in application purposes. Such as, data transfer, counter operation and display data in seven segment LED display units and data to read data through key board respectively.

MODULE 5: Application of μP based system (6 Lectures)

Microprocessor based instrumentation system for measurement of physical parameters, such as- temperature, light intensity, smoke, moisture content etc. Operation electro-magnetic and static relay for switching operation. A traffic light control, speed controller of de motor etc.

Textbooks/Reference Books:

1. Microprocessor architecture, programming and applications—Ramesh S Gaonakar –Penram International (T1)
2. Fundamentals of Microprocessors and Microcontrollers—B Ram—Dhanpat Rai Publications (T2)
3. The 8085 Microprocessor and Programming and Interfacing—K Udantkus—Pearson Education (T3)

Course Code	Course Title	Hours per week L-T-P	Credit
EI1815PE11	**Advanced Control System**	**3-0-0**	**3**

Prerequisites:
Control System

COURSE OBJECTIVES: To provide

- The knowledge of state variable and its application to control system,
- Nonlinear control system,
- Discrete control system
- Optimal control system.

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

CO1: Apply the knowledge of state variable to control system.

CO2: Analyze the nonlinear control system

CO3: Evaluate stability of a given linear and non-linear control system Analyze the discrete control system

CO4: To design an optimal control to meet specific criteria

CO5: Analyze and evaluate the stability of a given discrete control system.

MODULE 1: State Space Analysis (10 Lectures)
State Space Representation, Solution of State Equation, State Transition Matrix, Canonical Forms – Controllable Canonical Form, Observable Canonical Form, Jordan Canonical Form. Controllability and Observability: Tests for controllability and observability for continuous time systems – Time varying case, minimum energy control, time invariant case, Principle of Duality, Controllability and observability form Jordan canonical form and other canonical forms.

MODULE 2: Nonlinear Control system (8 Lectures)
Introduction to nonlinear systems, Types of nonlinearities, describing functions, describing function analysis of nonlinear control systems. Phase-Plane Analysis: Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

MODULE 3: Stability Analysis (6 Lectures)
Stability in the sense of Lyapunov., Lyapunov's stability and Lypanov's instability theorems. Direct method of Lypanov for the Linear and Nonlinear continuous time autonomous systems. Modal Control: Effect of state feedback on controllability and observability, Design of State Feedback Control through Pole placement. Full order observer and reduced order observer

MODULE 4: Optimal Control (3 Lectures)
Formulation of optimal control problem. State regulator problem. Output regulator problem. Tracking problem, Continuous-Time Linear Regulators.

MODULE 5: Discrete Time Systems (5 Lectures)
Introduction to discrete – time systems; Z- transform, inverse Z- transformation; solving difference equation by the Z-transform method; pulse- transfer function; stability analysis in the Z- plane.

Textbooks:

1. K. Ogata, Modern Control Engineering, PHI.
2. I.J. Nagarath, M.Gopal, Control Systems Engineering, NAI.
3. D. Roy Choudhury., Modern Control Engineering,PHI
4. B.N.Sarkar., Advanced Control System, PHI

Reference Books:

1. M. Gopal, Modern Control System Theory, New Age International.
2. Stainslaw H. Zak, Systems and Control, Oxford Press.
3. B.C. Kuo., Automatic Control System, PHI

Course Code	Course Title	Hours per week L-T-P	Credit
EI1815PE12	**Advanced Electrical Measurements**	**3-0-0**	**3**

COURSE OBJECTIVES:

- To study 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: analyze construction, working principle and applications of electronic and digital measuring instruments and methods.

CO2: develop systems for measurement of non-electrical physical quantities

CO3: analyze performance of measurement of electrical and non-electrical quantities

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: Electronic and Digital meters (9 Lectures)

(a) Electronic Voltmeters: Advantage & disadvantages of using electronic voltmeters; Different stages in AC & DC electronic voltmeters; Balanced bridge voltmeter; Principle and circuit diagrams for average responding, peak responding & RMS responding voltmeters. (b) Digital voltmeters: Classification of digital voltmeters; Principle, block diagram and signal wave form of ramp type, stair case ramp type and integrating type digital voltmeters. (c) Electronic Multimeter & Q-meter.

MODULE 3: Digital Storage Oscilloscopes (10 Lectures)

Block diagram representation of DSO circuit; Principles of operation of Digital Storage Oscilloscopes (DSO); Measurement of voltage, current, frequency using DSO.

MODULE 4: Transducers (7 Lectures)

Classification and Selection of Transducers - Primary and Secondary Transducers; Construction, Principle of Operation and Applications of Diaphragms, Bellows, Bourden Tubes, Springs, Capacitive, Piezoelectric and Photoelectric Transducers; Strain Gauges; Hall sensors; Linear Variable Differential Transformer (LVDT); Measurement of non-electrical physical quantities: temperature, pressure, torque, flow, Speed and Position

MODULE 5: Recorders (5 Lectures)

Different types of recorders; Construction, working principle and circuit diagrams of Strip-chart & X-Y recorders

Text Books:

1. Electrical Measurements and Measuring Instruments 2nd Ed 2013 – R. K. Rajput, S. Chand & Co
2. A Course in Electrical and Electronic Measurements and Instrumentation 19th Ed 2011 - A. K. Sawhney and Puneet Sawhney, Dhanpat Rai & Sons

Reference Books:

1. Electronic Instrumentation, 3rd Ed 2010 - H. S. Kalsi, McGraw Hill
2. Electrical Measurement and Measuring Instruments by U.A Bakshi, A.V. Bakshi
3. Golding and Widdis – Electrical Measurements and measuring instruments. AH WHEELER & Company
4. A Course in Electrical and Electronic Measurements and Instrumentation 14th Ed 2014 – J. B. Gupta, S. K. Kataria & Sons.
5. Electronic Instrumentation and Measurements 3rd Ed 2013 – Davis A. Bell, Oxford University Press
6. Electrical Measurement and Measuring Instruments 2011 - E.W. Golding and F.C Widdis, Reem Publications Pvt. Ltd.

Course Code	Course Title	Hours per week L-T-P	Credit
EI1815PE13	Computer Organization	3-0-0	3

COURSE OBJECTIVES:

- To study fundamental concepts and design circuits of Computer Organization

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

CO1: analyze construction of digital general-purpose computer.

CO2: analyze the working principle of basic building blocks (processor, memory, input/output devices) of digital general-purpose computer and their sequential/parallel operation.

CO3: design digital general-purpose computer

MODULE 1: Computer Evolution and Arithmetic (8 Lectures)

A Brief History of computers, Designing for Performance, Von Neumann Architecture, Hardware architecture, Computer Components, Interconnection Structures, Bus Interconnection, Scalar Data Types, Fixed and Floating-point numbers, Signed and unsigned numbers, Integer Arithmetic, 2's Complement methods for multiplication and division, Booths Algorithm, IEEE standards, Hardware Implementation.

MODULE 2: The Central Processing Unit (8 Lectures)

Machine Instruction characteristics, types of operands, types of operations, Addressing modes, Instruction formats, Instruction types, Processor organization, Intel 8086 as example, Programmers model of 8086, max/min mode, Register Organization, Instruction cycles, Read Write cycles.

MODULE 3: The Control Unit (6 Lectures)

Single Bus Organization, Control Unit Operations: Instruction sequencing, Micro operations and Register Transfer. Hardwired Control: Design methods – State table and classical method, Design Examples - Multiplier CU. Micro-programmed Control: Basic concepts, Microinstructions and microprogram sequencing.

MODULE 4: Memory Organization (6 Lectures)

Characteristics of memory systems, Internal and External Memory, Types of memories: EEPROM, DDR4 SDRAM, High-Speed Memories: Cache Memory, Organization and Mapping Techniques, Replacement Algorithms, Cache Coherence, MESI protocol. Virtual Memory: Main Memory allocation, Segmentation, Paging, Address Translation Virtual to Physical.

MODULE 5: I/O Organization (6 Lectures)

Input/Output Systems, Programmed I/O, Interrupt Driven I/O, 8086 Interrupt structure, Direct Memory Access (DMA), Buses and standard Interfaces: Synchronous, Asynchronous, PCI, SCSI, USB Ports, Secondary Storage: Magnetic Disk drives, Optical memory drives, Flash drives, USB Pen drives, Solid state drives.

MODULE 6: Parallel Organization (6 Lectures)

Instruction level pipelining and Superscalar Processors, Multiple Processor Organizations, Closely and Loosely coupled multiprocessors systems, Symmetric Multiprocessors, Clusters, Vector Computations, RISC: Instruction execution characteristics, RISC architecture and pipelining

Text Books:

1. W. Stallings: Computer Organization and Architecture: Designing for performance, Prentice Hall of India.
2. C. Hamacher, V. Zvonko, S. Zaky: Computer Organization, McGraw-Hill.

Reference Books:

1. Jatindra Kumar Deka: Computer Organization and Architecture, Web Course of NPTEL
2. D. Paterson, J. Hennesy: Computer Organization and Design: The Hardware Software Interface, Morgan Kauffman
3. John L Hennessy and David Patterson: Computer Architecture A Quantitative Approach, Morgan Kauffman
4. P. Paul Choudhury: Computer Organization and Design, Prentice Hall of India
5. J. Hays: Computer Architecture and Organization, McGraw-Hill.
6. W. Stallings: Computer Organization and Architecture: Principles of Structure and Function, Maxwell Macmillan Editions.
7. A. S. Tanenbaum: Structured Computer Organization, Prentice Hall of India.
8. G. George: Computer Organization: Hardware and Software, Prentice Hall of India.

Course Code	Course Title	Hours per week L-T-P	Credit C
EI1815PE14	**Electrical System Design and Drawing**	**3-0-0**	**3**

COURSE OBJECTIVES:

- To study fundamental concepts of Electrical System Design & Drawing

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

CO1: draw different parts of electrical machines and domestic electrical wiring circuit diagram

CO2: design electrical machines and domestic electrical wiring circuit

CO3: determine costs and capacities of electrical machines and domestic electrical wiring systems

MODULE 1: Fundamentals of Electrical Machine Design (3 Lectures)

Standard specification of frame size, conductors and insulation; Magnetization and loss curve; Choice of specific loading; Heating and cooling of electrical machines.

MODULE 2: Design of D.C. Machines (10 Lectures)

Construction details; Output equation; Main dimension; Choice of specific loadings; Choice of number of poles; Armature design; Design of field poles and field coils; Design of commutator and brushes.

MODULE 3: Design of Transformers (10 Lectures)

Construction details of core and shell type transformers; Output rating of single phase and three phase transformers; Optimum design of transformers; Design of yoke, core and winding for core and shell type transformers; Equivalent circuit parameter from designed data; Design of tank and cooling tubes of transformers.

MODULE 4: Design of A.C. Machines (10 Lectures)

Construction details of A.C. machines; Output equation; Main dimensions; Choice of specific loadings; Design of stator; Design of squirrel cage and slip ring rotor; Equivalent circuit parameter from designed data; Short circuit ratio; Design of rotor of cylindrical pole and salient pole machines.

MODULE 5: Domestic Wiring (5 Lectures)

Types of cables (names only); Types of wiring; Circuit layouts: single-phase A.C mains to DB; 3-phase connections; Accessories – Main switch, Ceiling rose, Fuse, MCB, DB; Megger; Testing of wiring installation; Earthing; Lamps: Fluorescent tube and its connection and operation; Indian Electricity Rules regarding electrical installation.

Suggested Practical:

Computer Aided Design: Assembly of elemental coefficient matrix, Global coefficient matrix, Application of FEM technique for design problems. Use of open source FEM software for 2D design, Computation of Capacitance of capacitor, cable, multi dielectric cable through FEM, Computation of electrostatic field for various geometry, skin and proximity effect in conductors. 2D FEM open source software based electrical apparatus design; 2D FEM open source software-based DC machine and Transformer part design.

Textbooks:

1. A Course in Electrical Machine Design – A. K. Sawhney and Chakrabarti, Dhanpat Rai & Co.
2. Electrical Engineering Drawing – S. K. Bhattacharyya, Wiley Eastern

Reference Books:

1. Computer aided design of electrical machines - K M Vishnu Murthy, B S Publications
2. An Introduction to the Finite Element Method - J. Reddy, TMH Publication
3. Principles of Electrical Machine Design - R.K. Agarwal, S. K. Kataria & Sons
4. Design of Rotating Machines – Juha Pyrhonen, Tapani Jokinen and Valeria Hrabovcova, Wiley – Blackwell
5. Electrical Machine Design Data Book - A. Shanmugasundaram, New Age International
6. Design of Electrical Machines – V. N. Mittle and Arvind Mittal, Standard Publishers Distributors
7. Electrical Machine Design – Seraj Ahamad, Vayu Education of India
8. Electrical Engineering Drawing – K.L. Narang (Satya prakash: New Delhi)
9. Computer Aided Design of Electrical Machines - V.K. Maurya, Ritu Raj Jallan and Shasya Shukla, S. K. Kataria & Sons
10. Guidelines for Electrical Works in Residential Building – Suruhanjaya Tenaga, www.st.gov.my
11. Elect. Drawing and Design – Surjit Singh
12. General electrical drawing – Arora and Chand (New Height, Delhi)
13. Sub-station Design & Equipments- Gupta & Satnam
14. Performance & Design of A.C Machines –M. G Say

Course Code	Course Title	Hours per week L-T-P	Credit C
EI1815PE15	**Electronic System Design**	**3-0-0**	**3**

COURSE OBJECTIVES:

- To study the techniques for designing Analog and Digital Electronic circuits using discrete devices and ICs.
- To learn fundamentals of software for simulating and testing analog and digital systems design.

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

CO1: draw the electronic devices and integrated circuits in details

CO2: design electronic systems

CO3: compute performance and costs of electronic systems

PART -1 Analog Electronic Systems

MODULE 1: Design of DC Power Supplies

Design of Regulated DC Power Supply Units – Design of FW Rectifiers, Capacitor and Inductor Filters, Combination Filters, Voltage Regulators, Use of IC Voltage Regulators. Introduction to SMPS.

MODULE 2: Design of Transistor Amplifiers and Switches

Interpretation of Data-Sheets of devices, Concept of Load Line, Negative Feedback Systems, Design of Cascaded Small Signal Amplifiers using BJT, JFET and MOSFET, Design of Power Amplifiers using BJT, MOSFET, and OPAMPS. Concept of Positive Feedback, Design of Oscillators and Signal Generators, Design of Switches using BJT, JFET, MOSFET.

MODULE 3: Design of Opamp Applications

Design of other OPAMP applications, Analog Computational Applications and Analog Electronic Simulations, Active Filters, Non-Linear applications, ADC and DAC. Design of applications using 555 Timers and PLL.

PART – II Digital Electronic Systems

MODULE 1: Design of Digital Systems

Review of Digital Logic Simplification techniques, VEM technique and Program-Table technique. Logic Implementation using- Universal Gates, Multiplexers, ROM, PLA and FPGA

MODULE 2: Design of State Machine

State Flow Diagram, State Transition Matrix, State Tables, and Excitation Table of Flip-Flops. Design of Digital Systems as State Machines. RTL Level Design of Digital Systems

MODULE 3: Introduction to Logic Specification Language

VHDL and VERILOG. Design of Digital Systems using VHDL. Design of Finite State Machine with VHDL

Suggested Practical:

MINI – PROJECT

1. One Hardware Project with Presentation of Software Simulation of (a) Transistorized Circuit, (b) OPAMP IC, (c) Timer IC, (d) PLL IC.
2. VHDL or VERILOG Simulation and Presentation of a State Machine and an RTL level design.

Text Books:

1. Linear integrated Circuits: Roy Choudhury & Jain: New Age International Publications.
2. Digital Electronics: Sanjay Sharma, Katsons

Reference Books:

1. OPAMPs and Linear Integrated Circuits: R.A. Gayakwad: Pearson India.
2. Digital Logic & State Machine Design: David J Comer: Oxford University Press.
3. Digital Logic and Computer Design: Moris Mano: Pearson India.
4. Fundamentals of Digital and Computer Design with VHDL: Richard S Sandige & Michael L Sandige: McGraw Hill India.
5. Electronic Devices and Circuits: David Bell: Oxford University Press.
6. Integrated Electronics –Millman & Halkias

Course Code	Course Title	Hours per week L-T-P	Credit C
EI1815OE11	**Data Structures and Algorithms Basics**	**3-0-0**	**3**

Prerequisites:

- Basic mathematics
- Basic understanding of text editor
- C programming language
- Compilation and execution of programs

COURSE OBJECTIVES:

The main objective of this course is to introduce the students to the basic concepts of data structures which are the programmatic way of storing data so that data can be used efficiently. Nowadays in every field various types of data are used in one way or the other. By applying data structures and algorithms (DSA), data can be organized in such a way that all items may not be required to be searched or sorted and the analysis can be performed almost instantly.

COURSE OUTCOMES: After completion of the course students will be able to

CO1: apply fundamental data structures for technical problem solving
CO2: apply the knowledge of DSA to organize the data in a systematic way to use it efficiently
CO3: demonstrate reduction in memory usage and running time of application programs
CO4: design algorithm for practical engineering and technical problem solving.

MODULE 1: Introduction to Data Structures and Algorithms (6 Lectures)

Need of DSA, Application of DSA, Characteristics of Data Structures. Basic terminology of Data Structures, Categories of algorithm, Characteristics of algorithms, Algorithm complexity, space complexity, time complexity.

MODULE 2: Data Structures (12 Lectures)

Basics of DSA, Array data structure, pointers, queue, stack, Linked lists, Doubly linked lists, circular linked lists.

MODULE 3: Searching Algorithms (6 Lectures)

Basics idea of searching algorithms and programs for-- Linear search, Binary search, hashing scheme

MODULE 4: Sorting Algorithms (7 Lectures)

Basic idea of sorting algorithms and programs for—
Bubble sort, Insertion sort, Selection sort, Merge sort, Quick sort and Radix sort.

MODULE 5: Graph Data Structure (5 Lectures)

Basic idea of graph, terminology of graph data structure. Algorithms and programs for representation of directed and undirected graphs as data structures.

MODULE 6: Tree Data structure (4 Lectures)

Basic idea of tree, terminology. Binary search tree representation and basic operations.

Text books:

1. M.A.Weiss-Data Structures & Algorithms Analysis in C++ , (Addition Wesley).
2. L. Tannenbaum- Data Structures Using C, (PHI).

Reference books:

1. Lipshutz- Theory and problems of Data Structure, (McGraw Hill).
2. A. N. Kamthane -Introduction to data structures in C (Pearson)

Course Code	Course Title	Hours per week L-T-P	Credit C
EI1815OE12	Computer Oriented Numerical Methods	3-0-0	3

Prerequisites:

COURSE OBJECTIVES:

The course is designed with the objective of inculcating ability and skill in software development applied to engineering applications. The numerical techniques are extensively used in engineering problem solving environment. Therefore, the course is developed in such a way that the numerical techniques are directly implemented using software platform (C-program technique). The course contains numerical techniques for solution of linear and nonlinear equation for single and multivariable systems. Linear and non-linear interpolation techniques are incorporated in the course. Finally, the numerical differentiation and integration and numerical solutions of differential equation techniques are taught in the course.

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

CO1. Define the basic concept of numbers representation and propagation of error in numerical computation.

CO2. Apply the iterative procedures for the solution of linear and non-linear set of equations involving matrix solution technique.

CO3. Demonstrate the basic role of interpolation, and to apply it to numerical differentiation.

CO4. To apply the concept of numerical integration for engineering applications

CO5. To apply the concept of numerical methods for the solution of ODE applied to engineering applications

MODULE 1: Computer Arithmetic (4 Lectures)

Introduction, Floating point representation of numbers and floating-point arithmetic, computational errors, Relative and absolute errors, Error propagation, Iterative processes- convergence and acceleration.

MODULE 2: Iterative methods (5 Lectures)

Transcendental equations, Methods of bisection, Method of false position, Newton Raphson method, Complex roots, Synthetic division.

MODULE 3: Matrices and Linear Systems of Equations (10 Lectures)

Matrix inversion, LU decomposition, Solution of linear system of equations by direct methods—Gauss elimination method, ill—conditioned system, Pivotal condensation, Gauss-Siedel iteration method, Gauss-Jordan matrix inversion, Eigen values and Eigen vectors, N—R method for non-linear system of equations.

MODULE 4: Finite Difference and Interpolation (10 Lectures)

Forward difference, Backward difference and central difference, Symbolic relations, Interpolation with equal intervals, Interpolation using forward difference, Newton's and Gauss's formula for interpolation, Interpolation with unequal intervals, Newton's formula, Lagrange's polynomial interpolation.

MODULE 5: Numerical Differentiation and Integration (5 Lectures)

Differentiation by polynomial fit, errors in numerical differentiation, numerical integration—Trapezoidal rule, Simpson's rule, Romberg method.

MODULE 6: Ordinary Differential Equations (6 Lectures)

Taylor's series method, Euler's method, Modified Euler's method, Runga-Kutta method, Predictor-Corrector method.

N: B: As there will be no practical classes for this subject student will be given 2 mini projects to utilize the concept that will involve programming.

Textbooks/Reference Books:

1. M. K. Jain, S.R.K. Iyengar, R.K. Jain: Numerical Methods for Scientific and Engineering Computation, New Age International
2. Srimanat Pal: Numerical Methods -Principles, Analysis, and Algorithms, Oxford
3. S Rajasekaran,: Numerical Methods in Science and Engineering - A Practical Approach, S.Chand
4. T Veerarajan, T Ramachandran: Numerical Methods with programming in C, TMH
5. S.S. Sastry: Introductory Methods of Numerical Analysis, PHI

Course Code	Course Title	Hours per week L-T-P	Credit C
EI1815OE13	**Digital Signal Processing**	**3-0-0**	**3**

Prerequisites: Signals and Systems

COURSE OBJECTIVES:

- To teach the basic concepts of Discrete Signals and Digital Signals
- To teach Digital Signal Processing Algorithms.

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

CO1: Represent signals mathematically in continuous and discrete-time, and in the frequency domain
CO2: Analyze discrete-time systems using z-transform.
CO3: Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
CO4: Design digital filters for various applications.
CO5: Apply digital signal processing for the analysis of real-life signals.

MODULE 1: Discrete-Time Signals and Systems (6 Lectures)
Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

MODULE 2: Z-transform (6 Lectures)
z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z- transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

MODULE 3: Discrete Fourier Transform (10 Lectures)
Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

MODULE 4: Design of Digital filters (12 Lectures)
Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

MODULE 5: Applications of Digital Signal Processing (6 Lectures)
Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Textbooks/Reference Books:

(a) J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall,1997.
(b) A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall,1989.

Course Code	Course Title	Hours per week L-T-P	Credit C
HS181506	**Engineering Economics**	**3-0-0**	**3**

Course Outcomes (COs):

The students will be able to

1. Acquire knowledge about economics its nature, scope and importance.
2. Understand the economic laws, principles, and theories and their relevance in present day situation.
3. Develop the ability of critical thinking to meet the challenges at the national and global problems.
4. Apply knowledge in finding out socio-economic problems and appropriate measures to deal with them.
5. Equip students with vital knowledge to run government and non-government institutions and bodies.
6. Assemble knowledge which is vital for industry and research and evolve proper policy for economic development.

MODULE 1: Introduction To Economics (3 Lectures)

Meaning and Definition of Economics, Nature and Scope of Economics, Concept of Micro and Macro Economics.

MODULE 2: Utility Analysis (3 Lecture)

Meaning of Utility, Utility Function, Consumers Equilibrium, Concept of Indifference Curve, properties of Indifference Curve, Equilibrium under Indifference Curve.

MODULE 3 : Demand and Supply Analysis (4 Lectures)

Law of Demand, Demand Function, Elasticity of Demand, Types of Elasticity of Demand, Measurement of Elasticity of Demand, Demand Forecasting, Law of Supply, Supply Function.

MODULE 4: Revenue, Production & Cost Analysis (4 Lectures)

Average, Marginal and Total Revenue, Revenue Function, Average, Marginal and Total Cost, Cost Function, Short and Long Run Cost Curves. Break Even Point, Managerial Uses of Cost Function, Cobb Douglas Production Function.

MODULE 5: Market Structure (4 Lectures)

Concept of Market, Price-Output Determination under Perfect Competition, Monopoly Market and Monopolistic Competition.

MODULE 6 : Money, Banking and National Income (8 Lectures)

Definition of Money, Function of Money, Index Numbers, Construction of Index Numbers, value of Money, Causes of Inflation, Functions of Commercial and central bank, Central bank and its monetary policy, Money Market and Capital Market, Functions of Stock exchange, Concept of National Income, Measurement of National Income, Concept of Investment.

MODULE 7: Introduction to Environmental Economics (5 Lectures)

Concept of Environmental Economics, Cost -Benefit Analysis, Social Cost, Externalities, Concept of Pareto Equilibrium, Externality, Market Failure.

MODULE 8: Public Finance (3 Lectures)

Introduction to Public Finance, Concept of Budget, Types of Budget, Budget Receipts, Concept of Goods and services Tax (GST)

Textbooks/Reference Books:

1. Managerial Economics by V. Agarwal: Pearson Pvt. Limited, New Delhi.
2. Engineering Economics by Dr. A. Ahmed & G. Begum: Chandra prakash, Guwahati
3. Principles of Engineering Economics with Application by Dr. Z. A. Khan, A. N. Siddiquee, B. Kumar, M. H. Abidi: Cambridge University Press.
4. Public Finance and Public Policy by Dr. R. K Choudhury: Kalayani publishers
5. Quantitative Methods for Economics by R. Veerachamy: New Age International Publication Ltd.
6. Micro and Macro Economics by Dr. M. L. Seth: Educational Publishers , Agra -3
7. A Koutsoyiannis: Modern Microeconomics
8. Environmental Economics by R. N. Bhattacharya: Oxford Publication.

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181512	Power Electronics Lab	0-0-2	1

COURSE OBJECTIVES:
To experience operation of SCR, GTO devices, principle of operation of converter, chopper, inverter and regulated power supply circuits.

COURSE OUTCOMES:
At the end of the course, the students will be able to
CO1: Build and operate Power Electronic circuits
CO2: Analyze results of operation of converter and inverter circuits
CO3: Write technical report

List of experiments: Hands-on experiments related to the course contents of Power Electronics which includes at least 12 from the following:

1. Draw V-I characteristics of SCR and measure latching and holding currents
2. Study of UJT trigger circuit for half wave and full wave control.
3. Study of single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
4. Study of single phase (i) fully controlled (ii) half-controlled bridge rectifiers with resistive and inductive loads
5. Study of three - phase fully/half-controlled bridge rectifier with resistive and inductive loads.
6. Study of single-phase ac voltage regulator with resistive and inductive loads.
7. Study of single phase cycloconverter with resistive (R) and inductive (RL) loads.
8. Study of triggering of (i) IGBT (ii) MOSFET (iii) power transistor
9. Study of operation of IGBT/MOSFET chopper circuit
10. Study of MOSFET/IGBT based single-phase series-resonant inverter.
11. Study of MOSFET/IGBT based single-phase bridge inverter.
12. Forced commutation circuits (Class A, Class B, Class C, Class D and Class E)
13. Single Phase Series Inverter with R & RL loads
14. Single Phase Parallel Inverter with R& RL loads

Textbooks:

1. P. S. Bimbhra, ―Power Electronics, Khanna Publishers

Reference Books:

1. Jamil Asghar, M. Syed ―Power Electronics, PHI
2. M. D. Singh, K B Khanchandani—Power Electronics, Tata McGraw Hill Publishing
3. C. W. Lander, ―Power Electronics, McGraw-Hill Publication
4. M. H. Rashid, ―Power electronics: circuits, devices, and applications, Pearson Education India, 2009.
5. N. Mohan and T. M. Undeland, ―Power Electronics: Converters, Applications and Design, John Wiley & Sons, 2007.
6. R. W. Erickson and D. Maksimovic, ―Fundamentals of Power Electronics, Springer Science & Business Media, 2007.
7. L. Umanand, ―Power Electronics: Essentials and Applications, Wiley India, 2009
8. Gray, P.E.& C.L.Scurle: Electronic Principles- Wiley Eastern.
9. Ramamoorthy, M.: An Introduction to Thyristors and their Applications- East West Press.
10. G. K. Dubey, S. R. Doradla, A. W. Joshi and R. M. K. Sinha : Thyristorized Power Controllers, New Age International, 2nd Ed 2012

Course Code	Course Title	Hours per week L-T-P	Credit C
EI181513	**Microprocessors Lab**	**0-0-2**	**1**

Prerequisites:

- Microprocessor 8085 and applications.

COURSE OUTCOMES:

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

CO1: To define the basic concept of programmable device and structural arrangement of 8085 and its instructions.

CO2: To define the general idea for interfacing memory devices and I/O devices to ensure unique address for each device

CO3: To define the basic concept of PPIs and their operational aspects.

CO4: To apply the knowledge of PPIs for different engineering applications

CO5: To demonstrate the basic evolutionary process leading to the development of microprocessor based system for a few practical applications

LIST OF EXPERIMENTS

Experiment 1: Familiarization of the Microprocessor Kit – (a) editing a program (b) Verifying the program (c) Executing the program and verifying the outcome of the program.

Experiment 2: Developing and testing simple program for data transfer –between memory to Microprocessor or Microprocessor to memory using direct and indirect instructions.

Experiment 3: Write a program to add the data stored in memory location CA00 and CA01. Store the result in memory location CA02, if there is a carry, store 01H in the memory locationCA03, and otherwise store 00H in memory location CA03.

Experiment 4: Developing and test program for transfer block of 100 data from starting location CA00 H to next block having starting location CB00 H

Experiment 5: Developing and test program for to sort a set of data in ascending order stored in memory starting at C050.

Experiment 6: Developing and test program performing addition on two numbers using interrupt RST 7.5 key.

Experiment 7: Develop and test program to blink the LED's interfaced to port A of 8255.

Experiment 8: Develop and test simple program for key board and & segment LED operation using 8279

Experiment 9: Group project to develop traffic light control program using the traffic light control

Note: Laboratory experiments are to be conducted using instruction sheets provided by the instructor

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ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B.TECH
ELECTRICAL ENGINEERING

6th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure

(From Academic Session 2018-19 onwards)

B.Tech 6th Semester
Semester VI/B. TECH/Electrical Engineering/EE

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	EE181601	Power System-III	3	1	0	4	30	70
2	EE181602	Electric Drives	3	0	0	3	30	70
3	EE181603	Electromagnetic Field Theory	3	0	0	3	30	70
4	EE1816PE2*	Program Elective-2	3	0	0	3	30	70
5	EE1816OE2*	Open Elective-2	3	0	0	3	30	70
6	HS181606	Accountancy	2	0	0	2	30	70
Practical								
1	EE181611	Power System Lab	0	0	2	1	15	35
2	EE181614	Electronics Design Lab	0	1	4	3	15	35
TOTAL			17	2	6	**22**	**210**	**490**
Total Contact Hours per week: 25								
Total Credits: 22								

N.B. 4-6 weeks Mandatory Industry Internship need to be done in the 6th semester break and the report is to be submitted and evaluated in 7th semester

Programme Elective-2 Subjects

Sl. No.	Subject Code	Subject
1	EE1816PE21	Principles of Telecommunication Engineering
2	EE1816PE22	Embedded System
3	EE1816PE23	Optimal and Adaptive Control System
4	EE1816PE2*	Any other subject offered from time to time with the approval of the University

Open Elective-2 Subjects

Sl. No.	Subject Code	Subject
1	EE1816OE21	Operating Systems
2	EE1816OE22	Complex Analysis
3	EE1816OE23	Digital Image Processing
4	EE1816OE24	Optimization Techniques in Engineering
5	EE1816OE2*	Any other subject offered from time to time with the approval of the University

Detailed Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
EE181601	**Power System-III**	**3-1-0**	**4**

Course Outcomes (COs): After the successful completion of the course student should be able to:

CO1. Understand the concept of modern power system after restructuring along with the concept of smart grid

CO2. Recognize and classify any substation or switchgear equipment. Understand its necessity, the function it serves and comprehend the advantage it affords to the whole system.

CO3. Understand use of fuses and circuit breakers in protecting the system, compare different types based upon medium of arc interruption and voltage levels. Understand theories and ratings of circuit breaker; analyze phenomenon of current chopping and interruption of capacitive current and the testing procedures. Be capable of selecting proper fuse ratings and CB's for protection for different equipment and voltages.

CO4. Understand use of relays their function and types. Comprehend and analyze different relays e.g. over-current, distance, differential etc used for protection of alternators, transformers, transmission lines and get a brief overview of carrier current protection schemes.

CO5. Understand and recognize HVAC and HVDC systems, different components, DC links, comprehend the advantages of HVDC systems and applications in different scenarios.

MODULE 1: Basic Concepts (2 Lectures)

Structure of a Power System, Bulk Power grids & Micro Power grids, Present day scenario of the system after deregulation & restructuring

MODULE 2: Static Substations (4 Lectures)

Substations: Classification. Interconnection of substations, Necessity. Function & arrangement of different substation equipment

Bus bar arrangements: selection criteria, single line diagram of single, duplicate, sectionalized, one & half CB, ring & mesh arrangements

Current limiting reactors: Types and construction, Location of reactors, substation grounding

MODULE 3: Fuses & Circuit Breakers (9 Lectures)

Fuses: Definition &Function. Important terms & classification. HRC fuses, Characteristics & advantages. Time delay fuses. Selection of fuses

Circuit breakers: Definition & Function, principles of circuit breaking. DC & AC circuit breaking theory, Arc voltage and current waveforms. Analysis of Restriking & Recovery voltages. Theories of Arc interruption. Phenomena of current chopping & capacitive current breaking. ACCB ratings. Working principle, construction, advantages & disadvantages of-Bulk oil CB & MOCB, Air CB, Air Blast CB, Vacuum CB&SF_6CB. Testing of circuit breakers

MODULE 4: Protective Relays (9 Lectures)

Definition. Terminology & functional characteristics of Protective relays. Universal Relay-Torque equation. **Operating principles of:** Over current relays. Differential relays. Distance

relays. Feeder, generator & transformer protection. Power Swing analysis & effect on distance relays. Carrier current protection. Comparators.
Static relays: operating principles, types & advantages. Block diagrams.
Numerical relays: operating principles, types & advantages. Block diagrams

MODULE 5: Over Voltage Phenomena, Protection & Insulation Co-Ordination
(12 Lectures)

Lightning phenomena, switching surges, Travelling waves, Shape and specification of travelling waves, Attenuation and distortion of travelling waves, Attenuation due to Corona, Behavior of travelling waves at a line transition
Introduction to Insulation coordination. Volt-time curve. Important terminology. BIL & factors affecting it. Coordination of system equipment. Overvoltage protection. Terms used. Ground wires, tower footing resistance & counterpoises. Different types of lightning arresters & surge absorbers. Location &rating of lightening arresters

MODULE 6: HVDC Transmission and Systems **(4 Lectures)**

Limitations of HVAC transmission. Advantages & limitations of HVDC transmission. Kinds of DC links. Ground return. Equipment for HVDC transmission. Application of HVDC systems. Advantages and Limitations of using high transmission voltages

Textbooks/ Reference Books:

1. Electrical Power - S.L. Uppal
2. Electrical Power Systems - C.L. Wadha
3. Switchgear & Protection - S.S. Rao
4. Power System Protection & Switchgear - B. Ram & D.N. Vishwakarma
5. HVDC Power Transmission Systems – K.R.Padiyar
6. Electrical Power System Design - M.V. Despande
7. Switchgear Principles - P.H.J. Crane
8. Power System Protection and Switchgear- B. Ojha
9. Power System Protection- P. M. Anderson

Course Code	Course Title	Hours per week L-T-P	Credit C
EE181602	**Electric Drives**	**3-0-0**	**3**

Course Outcomes (COs): At the end of the course, the student will be able:
CO1: To differentiate among various types of electric drives their dynamics and apply them for industrial applications
CO2: To choose an appropriate value of resistance for starting of motors and braking of electric motor
CO3: To apply the relations of heating and rating of a motor for choosing type and size of motor and enclosures suitable for different applications
CO4: To apply power electronics circuits for control of elective drives and to design simple systems for closed loop control of drives
CO5: To analyse different kind of processes involved in drives used in industries

MODULE 1: Dynamics of Electric drives (5 hours)
Classification of electric drives, types of load, speed-torque characteristics of loads and motors, selection of motors, dynamics of motor- load combination, four-quadrant operation, moment of inertia, stability of electric drives

MODULE 2: Starting and Braking of Electric Motors (10 hours)
Effect of starting on power supply, motor and load, starting methods, automatic starting circuits: time and current limit acceleration, energy relations and reduction of energy loss during starting.
Braking methods, speed-torque characteristic under braking conditions, energy relations during braking

MODULE 3: Heating & Rating and Mechanical Features for Electrical Motors (5 hours)
Heating and cooling of motors, loading condition and classes of duty, power rating and selection of motors for different applications, load inertia and load equalization.
Types of enclosures, bearings, mountings and transmission of drive, reduction of noise

MODULE 4: Multi-Quadrant DC Drive (8 hours)
Review of motoring and generating modes operation of a separately excited dc machine, single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive.
Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design

MODULE 5: Induction Motor Drives (8 hours)
Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation.
Speed control of 3 phase Induction Motors - Stator control: PWM &V/f control, Rotor control: rotor resistance control, Static control of rotor resistance using DC chopper, Static Krammer and Scherbius drives, Introduction to Vector Controlled Induction Motor Drives

MODULE 6: Synchronous Motor and BLDC Motor Drives (4 hours)

Speed control of 3 phase Synchronous Motors - True synchronous and self-controlled modes of operation, **PMSM:** principle, flux-density distribution, types. BLDC motor: Principle, drive scheme, converter topologies

Textbooks:

1. S. K. Pillai, –Fundamentals of Electrical Drives‖, Tata McGraw-Hill
2. G. K. Dubey, –Fundamentals of Electrical Drives‖, CRC Press, 2002

References:

1. G. K. Dubey, –Power Semiconductor Controlled Drives‖, Prentice Hall, 1989
2. R. Krishnan, –Electric Motor Drives: Modeling, Analysis and Control‖, Prentice Hall, 2001
3. W. Leonard, –Control of Electric Drives‖, Springer Science & Business Media, 2001

Course Code	Course Title	Hours per week L-T-P	Credit C
EE181603	**Electromagnetic Field Theory**	**3-0-0**	**3**

Course Outcomes (COs): After the successful completion of the course student should be able to:

CO1: To differentiate different types of coordinate systems and use them for solving the problems of electromagnetic field theory

CO2: Apply vector calculus and formulate potential problems within electrostatics, magneto statics and stationary current distributions in linear, isotropic media

CO3: Apply Poisson's and Laplace's Equation in solving complex problems in simple geometries using separation of variables and the method of images

CO4: Analyze Maxwell's equation in different forms and apply them to examine the phenomena of wave propagation in different media and its interfaces for diverse engineering problems

CO5: Applications in different fields of communication and analyze the nature of electromagnetic wave propagation in transmission line problems

MODULE 1: Vector Analysis (3 Lectures)

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

MODULE 2: The Static Electric Field (9 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 (7 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 a current loop

MODULE 4: The Electromagnetic Field (8 Lectures)

Faraday's law in integral and differential form (Maxwell's first curl equation for electro-magnetic field). The Lorentz force equation. The concept of displacement current and modified ampere's law (Maxwell's 2nd curl equation for electro- magnetic field), the continuity equation, power flow in an electromagnetic field, the poynting vector. Sinusoidally time varying fields, Maxwell's equation 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 (2 Lectures)

Current and current density, the continuity equation, conductor in fields. Dielectrics in fields: Polarization, flux density, electric susceptibility, relative permittivity, boundary conditions in perfect dielectrics, magnetic materials, magnetization, permeability, boundary conditions

MODULE 6: Applied Electromagnetic-I (3 Lectures)

Poisson's and Laplace's equations, solution of one-dimensional cases, general solution of Laplace's equation, method of images

MODULE 7: Applied Electromagnetic-II (8 Lectures)

Electromagnetic waves, the Helm Holtz Equation, wave motion in free space, wave motion in perfect lossy dielectrics, propagation in good conductors, skin effect. Reflection of uniform plane waves. Radiation of electromagnetic waves

Textbooks/Reference Books:

1. Engineering Electromagnetics: W H Hyat and J A Buck
2. Principles of Electromagnetics: N O Sadiku
3. Elements of Electromagnetic Fields: S P Seth
4. N. N. Rao: Basic Electromagnetics with applications.
5. Corson and Lofrain: Introduction to Electromagnetic Fields and waves.
6. Bradshaw and Byatt: Introductory Engineering Field Theory.

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1816PE21	**Principles of Telecommunication Engineering**	**3-0-0**	**3**

Course Outcomes (COs): After completion of the course students will be able to
CO1: apply the knowledge of mathematics, engineering fundamentals, to the solution of Analog communication engineering problems
CO2: demonstrate and apply the knowledge of multiplexing for communication
CO3: design circuits with the concepts of Pulse Modulation Techniques for different applications
CO4: apply the knowledge to detect and correct the errors that occur due to noise during transmission
CO5: apply knowledge to demonstrate ability to function in the field of digital communication

MODULE 1: Introduction to Communication Issues (6 Lectures)
History of communication, Issues of noise in communication, Sources and characteristics of different noise, thermal and shot noise, concept of white Gaussian noise. Noise temperature, noise bandwidth and noise figure

MODULE 2: Amplitude Modulation (8 Lectures)
Concept and need of Modulation, Generation and detection of Amplitude Modulation- AM-DSBFC, DSBSC, SSB, Square Law modulation, switching modulator, square law demodulator, Envelop detector, Balance Modulator, Power spectra of AM

MODULE 3: Angle Modulation (8 Lectures)
Generation and detection of Frequency and Phase Modulation – NBFM, WBFM, Transmission bandwidth, Indirect and direct method for FM generation, Frequency discrimination, PLL demodulation, Super heterodyne receivers, Frequency Division Multiplexing

MODULE 4: Random Signal Theory (4 Lectures)
Random variable – cumulative distribution function, probability distribution function, statistical averages, normal distribution, standard deviation, Gaussian and Rayleigh PDF

MODULE 5: Pulse Modulation (8 Lectures)
PAM, PPM, PWM systems, Sample and hold circuit, Concept of PCM- generation and reconstruction, basic coding and quantization, quantization noise, non-uniform quantization and companding, signal to quantizing noise power ratio, Signaling Format, Time Division Multiplexing

MODULE 6: Digital Communication Systems (6 Lectures)
Generation and detection of ASK, PSK, FSK. Applications of Digital Communication Systems

Textbooks:

1. Modern Digital and Analog Communication System, B.P.Lathi, Oxford University press, India
2. Communication Engineering, Sanjay Sharma, S.K.Kataria & Sons

Reference Books:

1. Communication System, Simon Haykins, John Wiley & Sons
2. Communication System, V. Chandrasekar, Oxford University press, India

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1816PE22	**Embedded System**	**3-0-0**	**3**

Course Outcomes (COs): After the successful completion of the course student should be able:
CO1: To define the basic concept and function of programmable device and structural arrangement of such device
CO2: To demonstrate the architecture of 8051 with special reference to the instructions available for software development
CO3: To define use of SFRs for vector interrupts for timer and serial data transfer operations
CO4: To apply the knowledge of microcontroller in the development process of embedded system. Such as, key board, display unit and application based interfaced system according to the task of the system
CO5: To apply the knowledge of Advanced Microcontroller for the development of embedded systems

MODULE 1: Introduction (5 Lectures)
Introduction to Programmable device, concept of common BUS, operation of a programmable device, design and realization of a simple programmable device Microcontroller/Microprocessor) with simple instructions like – data transfer, ALU operations, port operation etc. History of Microcontroller and Microprocessor. Difference between Microcontroller and Microprocessor. MPU of different categories- such as Microcontroller-8051, AVR etc, their specific features, advantages

MODULE 2: Microcontroller 8051 (3 Lectures)
Introduction. MCS-51 Architecture. Registers, I/O Ports. Memory organization. Hardware interrupts, Timer and Serial input/out

MODULE 3: Assembly and C Programming of Microcontroller 8051 (10 Lectures)
Instructions- Addressing modes, Arithmetical. Logical. Jumps. Loops and Call etc. Interrupts, Timers/ Counters and Serial Communications

MODULE 4: Application of MCS-51 (10 Lectures)
Interfacing LCD., Key board, principle DAC and ADC-Multi-channel programmable parallel data BUS ADC, Multi-channel programmable SPI base ADC. Basic features of an embedded system used for real-time practical application. Data- logger. Development of instrumentation system for measurement of - light intensity, temperature, pressure, flow, frequency, pulse width, voltage, angular speed etc. Generation of PWM wave. PID controller, analytical instruments such as Sequential control and interlock control

MODULE 5: Introduction to AVR ATmega 8/16/32 (12 Lectures)
Introduction to AVR ATmega 8/16/32, Basic port operation, configuration in-built ADC for sampling analog signal, serial data communication thorough TxD and RxD. fundamental of timer operations and EEPROM data read write operation

Textbooks:

1. Microcontrollers: Theory and Applications – by A V Deshmukh
2. The 8051 Microcontroller and Embedded system using assembly and C. – Md Ali Mazidi, Rolin D. Mc-Kindly and Janice Gillistie.
3. The AVR Microcontroller and Embedded using assembly and C. - Md Ali Mazidi, Sarmad Naimi and Sepehr Naimi

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1816PE23	**Optimal and Adaptive Control System**	**3-0-0**	**3**

Course Outcomes (COs): After completion of the course students will be able to
CO1: formulate mathematical models of optimal and adaptive control problems
CO2: analyze stability of optimal and adaptive control systems
CO3: design optimal and adaptive control systems to meet desired specifications

MODULE 1: Basic Approaches (2 Lectures)
Basic approaches to adaptive control; Applications of adaptive control

MODULE 2: Gradient and Least-Squares Algorithms (9 Lectures)
Linear error equation. Gradient and normalized gradient algorithms. Least-squares algorithms (batch, recursive, recursive with forgetting factor). Convergence properties

MODULE 3: Identification (8 Lectures)
Identification of linear time-invariant systems. Adaptive observers. Sufficient richness condition for parameter convergence. Equation error and output error methods

MODULE 4: Indirect Adaptive Control (7 Lectures)
Pole placement adaptive control. Model reference adaptive control Predictive control. Singularity regions and methods to avoid them

MODULE 5: Optimal Control (14 Lectures)
Formulation of optimal control problem. State regulator problem. Output regulator problem. Tracking problem, Continuous-Time Linear Regulators, Conditions for optimality, Calculus of variations, Pontryagin's maximum principle, Hamilton Jacobi-Bellman theory, dynamic programming, structures and properties of optimal systems, various types of constraints, singular solutions, minimum time problems, optimal tracking control problem

Text Books:

1. K.S. Narendra and A.M. Annaswamy: Stable Adaptive Systems, Prentice-Hall, 1989
2. D. E. Kirk: Optimal Control Theory: An Introduction, Prentice-Hall, 2004

Reference Books:

1. K.J. Astrom and B. Wittenmark: Adaptive Control, Addison-Wesley, 2nd edition, 1995
2. G.C. Goodwin and K.S. Sin: Adaptive Filtering, Prediction, and Control, Prentice-Hall, 1984
3. P. Ioannou & B. Fidan: Adaptive Control Tutorial, SIAM, Philadelphia, PA, 2006
4. P.A. Ioannou & J. Sun: Robust Adaptive Control, Prentice Hall, Upper Saddle River, NJ, 1996. The book is available (for free) in PDF form through the web page: http://www-bcf.usc.edu/~ioannou/RobustAdaptiveBook95pdf/Robust_Adaptive_Control.pdf.
5. I.D. Landau, R. Lozano, and M. M'Saad: Adaptive Control, Springer Verlag, London, 1998
6. B.D.O. Anderson and J.B. Moore: Optimal Control: Linear Quadratic Methods, 2007
7. M. Krstic, P. V. Kokotovic, I. Kanellakopoulos: Nonlinear and Adaptive Control Design, John Willey and Sons, 1995
8. K. J. Astrom and B. Wittenmark, Adaptive Control, 2/e, 2008
9. G. Feng and R. Lozano, Adaptive Control Systems, Oxford University Press, 1999
10. Sage A. P, White C. C, Optimum Systems Control, 2nd Edition, prentice Hall, 1977

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1816OE21	**Operating Systems**	**3-0-0**	**3**

Course Outcomes (COs): After completion of the course students will be able to

CO1: explain the terms and definitions concerned with Operating System of modern general purpose computer

CO2: analyze the performances of Operating System of modern general purpose computer

CO3: design Operating System of modern general purpose computer

MODULE 1: Purpose of Operating Systems (OS) (1 Lectures)

Virtualization of Resources; Handling of Resource Sharing; Providing Common Services

MODULE 2: Scheduling and Process Management (7 Lectures)

Interrupts; Basics of Scheduling (Time slices, Pre-emptive Queueing, Common Scheduling Algorithms); Basics of Process Management (Context Switching, Process Swapping, Threads)

MODULE 3: Basics of Synchronization (4 Lectures)

Deadlock (Meaning and causes, common prevention mechanisms, common detection and recovery mechanisms); Critical Sections; Semaphores, Monitors; Spin Locks

MODULE 4: Virtual Memory (3 Lectures)

Basic Concept of Address Spaces; Segmentation; Paging (Working Set Concept, Common Paging Algorithms); Interactions with Hardware

MODULE 5: Caching and Buffering (7 Lectures)

Basics of cache design (Hit ratio, LRU and Other Common Cache replacement strategies); Purpose of I/O Buffers and their use

MODULE 6: Basics of OS Architecture (3 Lectures)

Kernels, Microkernels and Layering; Out-of-Kernel Services

MODULE 7: Basics of Interprocess Communications (5 Lectures)

Shared Memory Mechanisms; Messages; Remote Procedure Calls (RPCs)

MODULE 8: Basics of File Systems (2 Lectures)

Directories; Basic Issues of File System Layout on Disk; Basic File System Protection Mechanisms

MODULE 9: Basics of Security (8 Lectures)

Access control mechanisms (Access Control Lists, Capabilities); Basic Ideas of Encryption and Authentication (Fundamentals of Encryption, Keys, Digital Signatures)

Textbooks:

Andrew S. Tanenbaum: Operating Systems Design and Implementation, PHI

Reference Books:

G. Nutt: Operating Systems: A Modern Perspective, Addison-Wesley

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1816OE22	**Complex Analysis**	**3-0-0**	**3**

Course Outcomes (COs): After completion of the course students will be able to
CO1: define spaces and explain proofs of theorems of spaces
CO2: analyze measurable functions in spaces
CO3: analyze applications of spaces and measures

MODULE 1: Space Concept (5 Lectures)
Vector spaces, Metric Spaces, Normed Spaces and Banach Spaces, Linear Operators, Inner Product and Hilbert Spaces: Basic definitions and Theorems; Examples: Sequence Spaces and Function Spaces; Dimension concept

MODULE 2: Topology of Metric Spaces (8 Lectures)
Open, Closed, Dense sets and Closures; Heine-Borel and Ascoli-Arzela Theorems; Separability; Completeness; Compactness; Hilbert Spaces: Inner products and linear functional, Orthogonal sets, Trigonometric series; Banach Spaces: Consequences of Baires's theorem, Fourier series of continuous functions, Fourier coefficients of L^1-functions, Hahn-Banach theorem, Uniform Boundedness theorem, Open mapping theorem, Closed mapping theorem, Closed graph theorem, Abstract approach to Poisson integral

MODULE 3: Measure and Integration (8 Lectures)
Total variation; Absolute continuity; Consequences of Radon-Nikodym theorem; Bounded linear functional on L^p-spaces; Riesz representation Theorem; Regularity properties of Borel measures; Lebesgue Measure on Euclidean Space; Measurable and Lebesgue Integrable Functions on Euclidean Space; Convergence Theorems; Comparison of Lebesgue Integral with Riemann Integral; Convex functions and inequalities; L^p-spaces; Approximation by continuous functions; General Measures and Lebesgue L^p-spaces: Importance of Lebesgue's Ideas in Functional Analysis; Continuity properties of measurable functions

MODULE 4: Analytic Functions (3 Lectures)
Basic concepts; Line integrals of complex functions; Cauchy's theorems; Residues and isolated singular points; Mappings and elementary functions

MODULE 5: Differentiation (2 Lectures)
Derivatives of measures; Fundamental theorem of Calculus; Differentiable transformations

MODULE 6: Integration on Product spaces (5 Lectures)
Measurability on Cartesian products; Product measures; Fubini theorem; Completion of product measures; Convolutions; Distribution functions

MODULE 7: Fourier Transforms (4 Lectures)
Formal properties; Inversion theorem; Plancherel theorem; Banach algebra of L^1

MODULE 8: Harmonic Functions (5 Lectures)

Cauchy-Riemann equations; Poisson integral; Mean value property; Boundary behavior of Poisson integrals; Representation theorems; Subharmonic functions and Dirichlet's problem

Textbooks:

1. Karen Saxe: Beginning Functional Analysis, Springer
2. Walter Rudin - Real and Complex Analysis, McGraw-Hill Book Company

Reference Books:

1. John B. Conway - A Course in Functional Analysis, Springer
2. Georgi E. Shilov, Richard A. Silverman: Elementary Real and Complex Analysis, Dover Publication, New York
3. Erwin Kreyszig - Introductory Functional Analysis with Applications, John Wiley & Sons
4. Bernard R. Gelbaum: Modern Real and Complex Analysis, John Wiley & Sons
5. Walter Rudin: Functional Analysis, McGraw-Hill Book Company
6. Walter Rudin: Principles of Mathematical Analysis, McGraw-Hill Book Company
7. Robert C. Wrede, Murray R. Spiegel: Schaum's Outlines Advance Calculus, McGraw-Hill Book Company
8. Murray R. Spiegel: Schaum's outline of Theory and Problems of Complex Variables with an introduction to Conformal Mapping and its application SI(Metric) Edition, McGraw-Hill Book Company
9. Murray R. Spiegel, Seymour Lipschutz, John Liu: Schaum's Outlines Mathematical Handbook of Formulas and Tables, McGraw-Hill Book Company

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1816OE23	**Digital Image Processing**	**3-0-0**	**3**

Course Outcomes (COs):

CO1: Understand the mathematical foundations for digital manipulation of images; image acquisition

CO2: Understand 2D Fourier transform concepts, including the 2D DFT and FFT, and their use in frequency domain filtering.

CO3: Demonstrate understanding of spatial filtering techniques, including linear and nonlinear methods. Understand the Human Visual System (HVS) and its effect on image perception and understanding

CO4: Understand the fundamental image enhancement algorithms such as histogram modification, contrast manipulation, and edge detection and image compression technique like JPEG and MPEG

CO5: Implement practical techniques to write programs using MATLAB language for digital manipulation of images; image acquisition; preprocessing; segmentation; Fourier domain processing; and compression

MODULE 1: Fundamentals of Digital Image (4 Lectures)

Human Visual System and Image perception; Monochrome and colour vision models; Image acquisition and display; Video I/O devices; Standard video formats; Image digitization; display and storage; 2D signals and systems

MODULE 2: Image Enhancement and Restoration (8 Lectures)

Spatial and frequency domain enhancement Techniques (Histogram based techniques, smoothing, filtering, sharpening, Homomorphic filtering), Unconstrained and Constrained Restoration, Inverse filtering, Wiener filter

MODULE 3: Image Compression (8 Lectures)

Coding, Interpixel and Psychovisual Redundancy; Image compression models; Error free compression – Huffman, Arithmetic and LZW, Bit-Plane coding (Constant Area coding, 1-D & 2-D Run length coding), Lossless predictive coding; Lossy compression – Lossy predictive coding, Transform coding – (Discrete Fourier Transform, Walsh-Hadamard Transform, Discrete Cosine Transform, and Discrete Wavelet Transform methods), Image compression standards – JPEG using DCT & DWT Continuous Tone Still Image Compression standard, Basics of MPEG Video Compression standard

MODULE 4: Digital Geometry and its Application in Image (8 Lectures)

Neighbourhood, connectedness, path, holes and surroundness, Borders, distances, Medial axis transformation, shrinking and expanding, thinning, Morphological operations- Erosion, Dilation, Opening, Closing, Parallel implementation, Smoothing, Component labelling, Thinning

MODULE 5: Image Segmentation (6 Lectures)

Edge detection – Roberts, Prewitt, Sobel & Laplacian Operators, Edge linking and Boundary Detection – Local Processing, Global Processing via the Hough Transform to detect straight lines and parameterised curves

MODULE 6: Representation and Description (6 Lectures)

Representation: Chain codes, Polygonal Approximations, Signatures, Boundary Segments, Skeletons; Boundary Descriptors – length, diameter, major axis, minor axis, basic rectangle, eccentricity, curvature, shape numbers; Application of Image Processing

Textbooks:

1. Digital Image Processing - Rafael C. Gonzalez and Richard E. Woods, Pearson., 2009, 3rd Ed
2. Fundamental of Digital Image Processing, Anil K Jain, PHI, 1994
3. Computer Vision - D H Ballard and C M Brown, PHI.
4. Digital Image Processing- S Jayaraman, S.Essakirajan, T Veerakumar, TMH

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1816OE24	**Optimization Techniques in Engineering**	**3-0-0**	**3**

Course Outcomes (COs): At the end of the course, the student will be able to:

CO1: Analyze a decision making problem and construct a mathematical model of it
CO2: Apply classical optimization techniques to constrained and unconstrained optimization problems
CO3: Formulate and solve linear programming problems
CO4: Apply search methods to non-linear programming problems
CO5: Apply dynamic programming techniques to engineering problems

MODULE 1: Introduction
Introduction to optimization, Engineering Applications of optimization, Formulation of problems as mathematical programming problems, classification of optimization problems

MODULE 2: Classical Optimization Techniques
Single variable optimization, Multivariable optimization without constraints: necessary and sufficient conditions, Multivariable optimization with equality constraints: Lagrange's multiplier method; Multivariable optimization with inequality constraints: Kuhn Tucker conditions

MODULE 3: Linear Programming
Formulation of LPP, Graphical and simplex method of solution of LP problems, Duality in LP, Sensitivity analysis

MODULE 4: Non-linear Programming
Unconstrained algorithms: One-dimensional minimization methods, Direct search and Gradient methods; Constrained algorithms, Quadratic programming

MODULE 5: Dynamic Programming
Multi-stage decision process, Structure and characteristics of dynamic programming, principles of optimality, deterministic dynamic programming

Textbooks:
1. Engineering Optimization Theory & Applications, S.S. Rao, New Age International Pvt. Ltd.
2. Mathematical programming-Theory and Applications, S.M.Sinha, Elsevier

Reference Books:
1. Optimization Concepts and Applications in Engineering-A.D. Belegundu, T.R. Chandrupatia, Perason Education, Asia
2. Operations research- An Introduction-Taha, H.A. Pearson

Course Code	Course Title	Hours per week L-T-P	Credit C
HS181606	**Accountancy**	**2-0-0**	**2**

MODULE 1:
Concept and classification of Accounts, Transaction, Double Entry system of Book Keeping, Golden rules of Debit and Credit, Journal- Definition, advantages, Procedure of Journalising, Ledger, advantages, rules regarding Posting, Balancing of Ledger accounts, Trial Balance- Definition, objectives, procedure of preparation

MODULE 2:
Name of Subsidiary Books, Cash Book-definition, advantages, objectives, types of Cash Book, preparation of different types of cash books, Bank Reconciliation Statement, Regions of disagreement between Cash Book with Pass Book balance, preparation of Bank Reconciliation Statement

MODULE 3:
Final Account: Preparation of Trading Account, Profit and Loss Account with adjustments

MODULE 4:
Concept of Capital Expenditure and revenue Expenditure, Baddebts, Provision for Bad and Doubtful debts, Provision for discount on Debtors, Outstanding expenses, Prepaid expenses, Accrued Income

MODULE 5:
Introduction to Depreciation Accounting- Meaning, causes, factors, methods of charging depreciation etc.

Textbooks/Reference Books:

1. Theory and Practice of accountance- KR Das, KM Sinha, KS Pal Choudhury, Dr. A Rahman, PK Pujary
2. Book- Keeping & Accountancy- C Mohan Juneja, J R C Chawla, KK Sakseena
3. Double Entry Book- Keeping & Accountancy- JR Batliboi

Course Code	Course Title	Hours per week L-T-P	Credit C
EE181611	**Power System Lab**	**0-0-2**	**1**

Course Outcomes (COs): After the successful completion of the course student will be able to:

CO1: develop models for study of power flow, transients, stability, contingency, unit commitment, economic dispatch, protection in respect of a given power system

CO2: analyze power flow, transients, stability, contingency, unit commitment, economic dispatch, protection in respect of a given power system through simulation in computer and test kits

CO3: write technical report

EXPERIMENTS

Power System Lab should contain softwares like CYME, MI Power, MATLAB, LABVIEW, C++ and Numerical Relay based Transformer, Generator, Motor and Transmission lines (short, medium, long) with provision of at least dual supply (with automatic and manual synchronization facility) from grid and alternator and/or 3-phase inverter from battery

Sl. No.	Contents
1	Power flow analysis by Newton-Raphson method and Fast decoupled method
2	Transient stability analysis of single machine-infinite bus system using classical machine model
3	Contingency analysis: Generator shift factors and line outage distribution factors
4	Economic dispatch using lambda-iteration method
5	Unit commitment: Priority-list schemes and dynamic programming
6	Analysis of switching surge using EMTP: Energization of a long distributed-parameter line
7	Analysis of switching surge using EMTP: Computation of transient recovery voltage
8	Familiarization of Numerical Relay Test Kit
9	Simulation and Implementation of Voltage Source Inverter
10	Numerical Relay Setting: Protection of Transmission Lines, Alternator, Transformer and Motor simulating all types of faults
11	Co-ordination of Numerical over-current and distance relays for radial line protection

Textbooks:

1. Electrical Power Systems 6th Ed 2012 – C. L. Wadhwa, New Age International
2. Power System Protection and Switchgear 2nd Ed 2011 - Badri Ram and D. Vishwakarma, McGraw Hill

Reference Books:

1. Power System Protection and Switchgear 2nd Ed 2011 – B. Ravindranath, and M. Chander, New Age International
2. Switchgear Protection and Power Systems 13th Ed 2008 - Sunil S. Rao, Khanna Publishers
3. Art and Science of Protective Relaying 1977 - C. Russell Mason, Wiley Eastern.
4. Computer Relaying for Power Systems 2nd Ed 2012 - Arun G. Phadke and James S. Thorp, Wiley India
5. Electrical Power System 15th Ed – S. L. Uppal and S. Rao, Khanna Publishers
6. A Text Book on Power System Engineering 2008 - A. Chakrabarti, M. L. Soni, P. V. Gupta, U. S. Bhatnagar and, Dhanpat Rai & Co. Pvt. Ltd.
7. Power System Analysis and Design 2005 – B. R. Gupta, S. Chand & Co.
8. Switching, Protection and Distribution in Low-Voltage Networks: Handbook with selection criteria and planning guidelines for switchgear, switchboards, and distribution systems 2nd Ed 1994 – Siemens, Wiley VCH.
9. HVDC Power Transmission Systems – K. R. Padiyar
10. Electrical Power System Design - M.V. Despande

Course Code	Course Title	Hours per week L-T-P	Credit C
EE181614	**Electronics Design Lab**	**0-1-4**	**3**

Course Outcomes (COs): After the successful completion of the course student will be able to:
CO1: design electronic systems to meet the requirements of society, academia and industry
CO2: analyze the performance of electronic system after completion of its design
CO3: write technical report after completion and testing of electronic system
[1 (One) mini project or at least 2 (two) advance level design type experiments may be carried out in the following mixed or single categories; One or more quiz tests or class tests may be taken to assess and motivate the students]

Electronics Design Lab should have softwares like MATLAB Simulink, Microsim, Proteus, PSPICE, LABVIEW, Xilinx, VHDL, Verilog HDL; and hardwares like Microprocessor based system development kit, Microcontroller based system development kit, FPGA based system development kit like Xilinx and Vivado

Sl. No.	Title	Topics in the Module	No. of Lectures	No. of Practical hours
1	Microprocessor based design	Develop a microprocessor based system for smart home or industrial control	1	9
2	Microcontroller based design	Develop a microcontroller based system for smart home or industrial control	1	9
3	FPGA based design	Develop a FPGA based system for smart home or industrial control: Use Xilinx system	4	10
4	Testing of designed electronic system	Perform the desired tests and quality checks. Perform market surveys for outsourcing the developed electronic systems. Write technical reports on the developed electronic systems including the feedback from the sites of utility	1	5

Textbooks/ Reference Books:

1. Ramesh S Gaonkar: Microprocessor architecture, programming and applications, Penram International
2. B Ram: Fundamentals of Microprocessors and Microcontrollers, Dhanpat Rai Publications
3. K Udantkus: The 8085 Microprocessor and Programming and Interfacing, Pearson Education
4. Wayne Wolf: FPGA-Based System Design, Prentice Hall

5. Cem Unsalan, Bora Tar: Digital System Design with FPGA Implementation Using Verilog and VHDL, McGraw-Hill
6. Samir Palnitkar: Verilog Hdl, Pearson
7. B. Bala Tripura Sundari, T. R. Padmanabhan: Design through Verilog HDL, Wiley
8. Louise H. Crockett, Ross A. Elliot, Martin A. Enderwitz , Robert W. Stewart: The Zynq Book: Embedded Processing with the ARM Cortex-A9 on the Xilinx Zynq-7000 All Programmable SoC, Strathclyde Academic Media Publication
9. Sanjay Churiwala: Designing with Xilinx® FPGAs: Using Vivado, Springer
10. Xilinx Inc: Xilinx Student Edition 2.1i Software, Pearson
11. Alexander G. Dean: Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach, ARM Education Media

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ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
GUWAHATI

Course Structure and Syllabus
(From Academic Session 2018-19 onwards)

B.TECH
ELECTRICAL ENGINEERING
7th Semester

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure
(From Academic Session 2018-19 onwards)

B.Tech 7th Semester: Electrical Engineering
Semester VII/ B.TECH/EE

Sl. No	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	EE181701	Power System-IV	3	1	0	4	30	70
2	EE1817PE3*	Program Elective-3	3	0	0	3	30	70
3	EE1817PE4*	Program Elective-4	3	0	0	3	30	70
4	EE1817OE3*	Open Elective-3	3	0	0	3	30	70
5	HS181704	Principles of Management	3	0	0	3	30	70
Practical								
1	EE181722	Project-1	0	0	6	3	50	50
2	SI181721	Internship-III (SAI-Industry)	0	0	0	2	-	200
TOTAL			**15**	**1**	**6**	**21**	**200**	**600**
Total Contact Hours per week : 22								
Total Credit: 21								

Program Elective-3		
Sl. No.	**Subject Code**	**Subject**
1	EE1817PE31	High Voltage Engineering
2	EE1817PE32	Computer Networks
3	EE1817PE33	Pattern Recognition and Machine Learning
4	EE1817PE34	Speech Coding Techniques
5	EE1817PE3*	Any other subject offered from time to time with the approval of the University

Program Elective-4		
Sl. No.	**Subject Code**	**Subject**
1	EE1817PE41	FACTS
2	EE1817PE42	Renewable Energy Sources
3	EE1817PE43	Advanced Electrical Drives
4	EE1817PE4*	Any other subject offered from time to time with the approval of the University

Open Elective-3		
Sl. No.	**Subject Code**	**Subject**
1	EE1817OE31	Optoelectronics
2	EE1817OE32	Computer Vision
3	EE1817OE33	Electromagnetic Waves
4	EE1817OE34	Electrical and Hybrid Vehicles
5	EE1817OE3*	Any other subject offered from time to time with the approval of the University

Detail Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
EE181701	**Power System-IV**	**3-1-0**	**4**

Prerequisites: Electric Power System –I, Electric Power System – II, Electric Power System - III

Course Objectives:

The objective of this course is to provide students with a broad understanding of electricity generation by conversion of various forms of energy to electrical energy and associated technology, operation and decision making on power plants. Provide a detailed study on the analysis and economic related issues in power sectors. The impact of this course offers a wide understanding on the different types of power plant, its functions and their flow lines and issues related to them

Course Outcomes:

CO1: Identify various characteristics of thermal and hydal plants and to solve various kinds of economic dispatch problems as well as UC problem

CO2: Make use of various modes of hydro-thermal scheduling and to prepare short term hydro thermal schedules

CO3: Comprehend the concept of Power System interconnection and economics of interconnected system

CO4: Apply generation control techniques in single area and multi area experimenting LFC, AVR and AGC

CO5: Utilize knowledge of State Estimation in power system and IEEE study model

MODULE 1: Power Plants- ***Thermal power plant*** – Economical, and ecological issues. Line diagram of thermal power plant Boiler: classifications and operational issues, Super heater, Reheaters, Economizer, air heater, draft system, feed water heater, and evaporator, cooling water supply and cooling tower. Speed governor, station auxiliaries, Ash handling system for thermal power plant. Emission issue of thermal power plant.

Hydro power plant- Classification of hydro power plant, economic and ecological issues related to the selection of site of hydro power plant, Estimation of generation capacity of hydro power plant, Selection of turbine, plant layout, governor and hydro plant auxiliaries.

Nuclear power plant- Fundamental of nuclear fission, schematic of nuclear power plant, nuclear fuels and fertile materials, nuclear reactor, chain reaction, moderator, coolants, control of fission, reactor operation, types of reactors, economical, and ecological issues of nuclear power plant.

Other power plants- Solar PV power plant, principle and operation, standalone Solar PV power plant, Grid Connected Solar PV power plant, Wind power plant etc.

MODULE 2: Economic Operation of Thermal plants- Methods of loading turbo-generators, input-output curves, heat ratio and incremental cost, coordination equation, economic loading of units, with and without transmission loss, penalty factor, iterative methods of solving co-ordination equation, economic thermal dispatching with network losses considered, B-matrix loss formula and its derivatives, economic dispatch versus unit commitment(UC), constraints in UC, UC solution method, generation Scheduling, ,introduction to load forecasting.

MODULE 3: Automatic load frequency and voltage control- Concept of load frequency control (LFC), LFC model for single/multi area systems, tie-line control in interconnected system (multi area system), concept of voltage & reactive power control.

Textbooks/ Reference Books:

1. P.K. Nag, Power Plant Engineering, 3/e, TMH.
2. GK Nagpal, Power Plant Engineering, Khanna Publishers.
3. B.R. Gupta, Generation of Electrical Energy, S Chand and Company.
4. M.V. Despande, Elements of Electrical Power System Design, A.H. Wheeler.
5. S.L. Uppal, Electrical Power, Khanna Publishers.
6. Prabha KundurPower System stability & control

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817PE31	**High Voltage Engineering**	**3-0-0**	**3**

Course Objective: To introduce theory of high voltage breakdown phenomena and testing of insulation strength of dielectrics

Course outcomes: At the end of the course the students will be able to:

CO1: Analyze breakdown of dielectrics

CO2: Design generation of high voltage for testing insulation strength

CO3: Analyze performance of high voltage testing and measurement methods

MODULE 1: Breakdown of Gasses

Basic processes in gas breakdown, generation of electron avalanche, Townsend mechanism, secondary processes, criterion for spark breakdown, Streamer mechanism, time lag for spark breakdown, breakdown in electro negative gasses.

MODULE 2: Breakdown in Liquid Dielectrics

Liquid dielectric, origin, electrical conduction and breakdown phenomena of pure liquids, test cells, natural and induced conduction, Transformer oil; properties, purification.

MODULE 3: Breakdown in Solid Dielectrics

Intrinsic and related forms of breakdown in solids, measurement of intrinsic strength- preparation of the specimen, surface discharge phenomenon, positive and negative Lichtenbury patterns, discharge detection, breakdown of solid insulation by Tracking, lightening phenomena-nature and characteristic of lightening induced voltage, measuring instruments and devices, lightening protection.

MODULE 4: **Generation of High Voltage**

High voltage testing transformers, cascaded transformers, high frequency transformers, tesla coil, cascaded rectifier for DC high voltage, electrostatic generators, impulse generator; analysis of the basic circuit, multi-stage circuits, factors influencing design, general construction, triggering, synchronization of operation, delay cables.

MODULE 5: High Voltage Testing

Low frequency direct current, high frequency and impulse tests, terminology; disruptive discharge, flashover and puncture, withstand voltage, 50% disruptive discharge voltage, impulse wave, full and chopped wave, impulse ratio, volt-time curve; testing of overhead insulators, bushings, cables, arrangement of the test object, various tests and test conditions.

MODULE 6: High Voltage Measurements and Testing: Electrostatic voltmeters, potential dividers; resistive, capacitive and mixed resistive dividers, peak voltage measuring device, oscillographic measurements, Schering bridge, sphere and rod gaps. Types of High Voltage Tests; High Voltage Testing (Impulse) Transformers; Voltage Control by Variation of Alternator Field Current, Tapped Transformers; Induction Regulators; Control Gear and Protective Devices; Equipment for Voltage Measurement, Measurement of R.M.S., Peak, and Instantaneous Values of Voltages; Low Frequency High Voltage Tests; High Voltage D.C. Tests; High Voltage D.C. Testing of Cables; Localization of Faults in H.V. Cables; High Frequency H.V. Testing; Surge Testing; Basic Impulse Generator; Testing of Insulating Material; Impulse Testing of Transformer; H.V. Testing of Cables; Testing of Strength of Insulating Oils; High Voltage Testing of Porcelain Insulators.

MODULE 7: Insulation Design Principle
Classification of insulating materials, material of dielectric in parallel, dielectric hysteresis, high voltage cables, thermal and electrical cables, requirements of cable design, materials used, high voltage bushing types, basic applications, insulation of high voltage transformers.

MODULE 8: High Voltage Laboratory
HV plants and apparatus, HV connections, laboratory earthing and safety measures.

Textbooks/ Reference Books:

1. High Voltage Technology 2006 - L. L. Alston, Oxford University Press
2. Electrical Breakdown of Gases 1978 - J.M. Meek and J.D. Craggs, John Wiley & Sons
3. High Voltage Engineering 5th Ed 2013 – M. S. Naidu and V Kamaraju, McGraw Hill
4. High Voltage Engineering 3rd Ed 2012 – C. L. Wadhwa, New Age International
5. High Voltage Engineering Fundamentals 2nd Ed 2008 – E. Kuffel, W. S. Zaengl and J. Kuffel, Elsevier
6. A Course in High Voltage Engg- R. S. Jha, Dhanpat Rai
7. An Introduction to High Voltage Experimental Technique 1978 – D. Kind, John Wiley & Sons

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817PE32	**Computer Networks**	**3-0-0**	**3**

COURSE OBJECTIVES:

- To teach the basics of the working of the Internet.
- To teach fundamentals of the protocols involved in the working of various layers of the Internet.

COURSE OUTCOMES:

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

CO1: To Understand the Basics of the Working of the Internet.

CO2: To Study Various Internet Protocols.

CO3: To Understand Various Security Measures in Internetworking.

CO4: To Understand Various Uses of Computer Networking.

MODULE 1: Introduction to Internet

a) To study Topology of Internet.
b) To study structure of Internet, Internet standards and Internet administration.
c) To study protocol layering.

MODULE 2: The Physical Layer

a) To learn Information Theory.
b) To learn coding of data, conversion methods between various types of data and multiplexing techniques.
c) To learn about various transmission media.
d) To learn about Circuit Switching, Packet Switching and various switches.

MODULE 3: The Data Link Layer

a) To learn error detection and correction techniques.
b) To learn DLC protocols.
c) To learn MAC protocols.
d) To learn various wired and wireless LAN protocols.
e) To learn mobile telephone protocols.
f) To learn satellite systems.

MODULE 4: **The Network Layer**

a) To learn packet switching methods.
b) To learn congestion control techniques.
c) To learn IP, IPv4, ICMPv4,
d) To learn Unicast Routing and Multicast Routing
e) To learn about IPv6 and ICMPv6,

MODULE 5: The Transport Layer

a) To learn about transmission layer issues protocols.
b) To learn about UDP, TCP-IP, SCTP

MODULE 6: The Application Layer

a) To learn basics of WWW, HTTP, FTP, E-Mail and DNS
b) To learn issues concerning multimedia in Internet.
c) To learn basics of Internet Security.

Textbooks/ Reference Books:

1. Computer Networking:: Stallings :: TMH
2. Computer Networks:: Tannenbaum :: PHI
3. Data Communication and Networking :: Forouzan :: McGraw Hill India

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817PE33	**Pattern Recognition and Machine Learning**	**3-0-0**	**3**

COURSE OBJECTIVES:
To teach concepts of inculcating artificial intelligence in machines by different computational methods

COURSE OUTCOMES: At the end of this course, the students will be able to
CO1: describe structure, components and mathematical formulation of learning by machines
CO2: develop algorithms for learning and pattern recognition by machines
CO3: analyze performances and characteristics of machine learning and pattern recognition algorithms for utilization in societal, academic and industrial purposes

MODULE 1: Introduction to Machine Learning
Intelligent Machines, Data Representation, Diversity of Data, Forms of learning, Machine learning and data mining, Linear Algebra and Machine Learning Techniques

MODULE 2: Supervised Learning
Learning from observation, Bias and Variance, Computational Learning Theory, Estimating Generalization errors, Metrics for assessing regression, Metrics for assessing classification

MODULE 3: Statistical Learning
Descriptive Statistics in learning Techniques, Bayesian Reasoning, k-Nearest Neighbour (kNN) Classifier, Discriminant functions and Regression functions, Linear Regression with Least Square Error criterion, Logistic Regression for Classification Tasks

MODULE 4: Learning with Support Vector Machine (SVM)
Linear Discriminant Function for binary classification, Linear Maximal Margin classifier for overlapping classes, Non Linear classifier, Regression by SVM, Variants of basic SVM Techniques

MODULE 5: Learning with Neural Networks
Cognitive Machines, Neuron Models, Network Architectures, Perceptrons, Linear Neurons, Error correction delta Rule, Multilayer perceptron (MLP) networks, Radial Basis Function (RBF) networks, Genetic Neural Systems

MODULE 6: Fuzzy Inference System
Cognitive Uncertainty and Fuzzy Rule Base, Fuzzy Quantification of Knowledge, Fuzzy Rule Base and Approximate Reasoning, Mamdani Model, Neuro Fuzzy Inference model, Genetic Fuzzy Systems

MODULE 7: Data Clustering and Data Transformation
Unsupervised Learning, Engineering Data, Overview of basic clustering models, K-Means Clustering, Fuzzy k-means clustering, some useful data transformation, Introduction to PCA, Decision Tree Learning, Measuring of Impurity for evaluating Splits in Decision Trees, Pruning Decision Trees, Strengths and weaknesses of Decision Tree Approach

MODULE 8: Application of Machine Learning
Some Practical Application Implementation

Textbooks/ Reference Books:

1. M Gopal: Applied Machine Learning, McGraw Hill Education
2. Geoffry J. McLachlan: Discriminant Analysis and Statistical Pattern Recognition, John Wiley & Sons
3. Richard O. Duda, Peter E. Hart, David G. Stork: Pattern Classification, John Wiley & Sons
4. S. Theodoridis, K. Koutroumbas: Pattern Recognition, Elsevier
5. Keinosuke Fukunaga: Introduction to statistical pattern recognition, Morgan Kaufmann, Academic Press
6. Shai Shalev-Shwartz, Shai Ben-David: Understanding Machine Learning: From Theory to Algorithms Cambridge University Press, 2015
7. S. Rajasekaran, G. A. Vijayalakshmi Pai: Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, PHI 2017.
8. B. Yegnanarayana: Artificial Neural Networks, PHI 2015
9. Simon Haykin: Neural Networks, Pearson Education, 2003.
10. Laurance Fausett: Fundamentals of Neural Networks, Englewood cliffs, N.J., Pearson Education, 1992.
11. Jacek M. Zurada: Introduction to Artificial Neural Systems, Jaico Publishing Home, 2002.
12. U Dinesh Kumar Manaranjan Pradhan: Machine Learning using Python, John Wiley & Sons 2019
13. B. Kosko: Neural Networks and Fuzzy Systems, Prentice-Hall of India Pvt. Ltd., 1994.
14. G. J. Klir and T. A. Folger: Fuzzy Sets, Uncertainty and Information, Prentice-Hall of India Pvt. Ltd., 1993.
15. H.J. Zimmermann: Fuzzy Set Theory and Applications, Allied Publication Ltd., 1996.
16. Timothy J. Ross: Fuzzy Logic with Engineering Applications, Tata McGraw Hill, 1997
17. John Yen & Reza Langari: Fuzzy Logic – Intelligence Control & Information, Pearson Education, New Delhi, 2003.
18. Driankov, Hellendroon: Introduction to Fuzzy Control, Narosa Publishers.
19. David Goldberg: Genetic Algorithms and Machine learning, PHI
20. Z Michalewicz: Genetic Algorithms + Data Structures = Evolution Programs, 3rdEd, Springer, 1996.
21. T Baeck, D B Fogel, Z Michalewicz: Evolutionary Computation Vol 2 Advanced Algorithms and Operators, Institute of Physics Publishing, Bristol, UK, 2000
22. Y. Gong, W. Xu: Machine Learning for Multimedia Content Analysis, Springer
23. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar: Foundations of Machine Learning, MIT Press.
24. Simon Haykin: Neural Networks & Learning Machines, Pearson 2016

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817PE34	Speech Coding Techniques	3-0-0	3

Pre-requisite: Digital Signal Processing

Course Outcomes: At the end of the course the student will be able to

1. Model the speech signal
2. Analyze the quality and properties of speech signal.
3. Analyze quality of the processed speech signals.

MODULE 1: Speech Production and Modeling

Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid; Requirements of speech codecs–quality, coding delays, robustness

MODULE 2: Speech Signal Processing

Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation

MODULE 3: Linear Prediction of Speech

Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.

MODULE 4: Speech Quantization

Uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers, Adaptive Huffman coding, Arithmetic coding, LZW coding, Psychoacoustic model, Perceptual coding and masking techniques;

Vector quantization – distortion measures, codebook design, codebook types

MODULE 5: Scalar Quantization of LPC

Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF

MODULE 6: LPC Model

LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model

MODULE 7: Code Excited Linear Prediction

CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zero-state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP

MODULE 8: Speech Coding Standards

An overview of ITU-T G.726, G.728, G.729, MPEG Audio layers, Dolby AC3 standards

Textbooks/ Reference Books:

1. Speech Coding Algorithms: Foundation and Evolution of Standardized Coders - W.C. Chu, Wiley Inter science, 2003.
2. Fundamentals of Acoustics 4^{th} Edition – L. E. Kinsler, A. R. Frey, A. B. Coppens, J. V. Sanders, John Wiley & Sons, 2005.
3. Discrete-Time Speech Signal Processing - Thomas F. Quatieri, Pearson Education, 2002.
4. Fundamentals of Speech Recognition – L. Rabiner, B-H Juang, B. Yegnanarayana, Pearson.
5. Digital Processing of Speech Signals – L. R. Rabiner, R. W. Schafer, Pearson, 1993.
6. Speech Communication Human and Machine – D O 'Shaughnessy, Universities Press (India) Pvt Ltd, IEEE2001.
7. Speech and Language Processing - Daniel Jurafsky & James H.Martin, Pearson Education, 2000.
8. Spoken Language Processing - Xuedong Huang, Alex Acero, Hsiad, Wuen Hon, Prentice Hall, 2001.
9. Computer Speech – Recognition, Compression, Synthesis - M.R.Schroeder, Springer Series in Information Sciences, 1999.
10. Discrete Time Signal Processing - A. V. Oppehein and R.W. Schafer, PHI, 1992.
11. Digital Speech by A. M. Kondoz, 2nd Edition, Wiley Students Edition, 2004.
12. Speech and Audio Signal Processing - B.Gold and N.Morgan, John Wiley & Sons, 2000

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817PE41	**FACTS**	**3-0-0**	**3**

Pre-requisite:
Knowledge of power electronics based converters, various types of modulation techniques etc.

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

CO1: Explain working principles of FACTs devices, their applications etc.
CO2: Model various FACTs devices and to implement them in various existing algorithms
CO3: Analyze the characteristics of AC transmission and the effect of shunt and series reactive compensation
CO4: Explain working and protection of various HVDC system
CO5: Design HVDC substation, three phase full wave bridge converters of various pulses

MODULE 1: FACTs Devices
Description and characteristics of thyristor based FACTs devices, their representation, opportunities of FACTs, Basic types of FACTS controllers, Relative importance of different types of controllers, Models of FACTs devices and their implementation in various existing algorithms. Basic concepts of voltage sourced converters (VSC), single phase full wave bridge converter operation, single phase pole operation.

MODULE 2: Phase Shifters
Principle and operation of single phase phase shifter, steady state model of a static phase shifter (SPS), power circuit configuration of SPS, SPS applications.

MODULE 3: Series Compensation and Shunt Compensation
Steady state voltage regulation and prevention of voltage collapse, power flow control, series compensation schemes, working principle, model and application of TCSC and SSSC, principle of shunt compensation, effect of shunt compensation of power angle diagram, principle of operation, configuration and control of SVC, STATCOM configuration and control, application of SVC, STATCOM etc.

MODULE 4: UPFC
UPFC: Its working principle, construction, control, uses etc.

MODULE 5: DC Transmission Technology
Comparison of AC and DC Transmission (Economics, Technical Performance and Reliability); Application of DC Transmission; Types of HVDC Systems; Components of a HVDC system. Line Commutated Converter and Voltage Source Converter based systems.

MODULE 6: Analysis of Line Commutated and Voltage Source Converters
Line Commutated Converters (LCCs): Six pulse converter; Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters; Inverter Operation; Effect of Commutation Overlap; Expressions for average dc voltage, AC current and reactive power absorbed by the converters; Effect of Commutation Failure, Misfire and Current Extinction in LCC links

Textbooks/ Reference Books:

1. N G Hingorani, L Gyugyi—Understanding FACTS, IEEE Press
2. Y H Song, Allan T Jones---Flexible AC Transmission Systems, IEE Book
3. K.R. Padiyar,–HVDC Power Transmission Systems, New Age International Publishers, 2011.
4. S. Rao, –EHV-AC, HVDC Transmission and Distribution Engineering‖, Khanna Publishers
5. J. Arrillaga, –High Voltage Direct Current Transmission‖, Peter Peregrinus Ltd., 1983.
6. E. W. Kimbark, –Direct Current Transmission‖, Vol.1, Wiley-Interscience, 1971.
7. S.L. Uppaland S. Rao, –Electrical Power Systems‖, Khanna Publishers

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817PE42	Renewable Energy Sources	3-0-0	3

Objectives

Introduce fundamental concepts in Renewable Energy Sources, advantages and disadvantages, design, simulation and their applications.

Course Outcomes

CO1: To comprehend the world energy situation and the notion of distributed end use energy and to understand the bad effects of the present concentration use of energy.

CO2: To understand the different types of renewable energy sources, their advantages/disadvantages and applications

CO3: To able to know the basics of solar energy and to be able to design and development of solar photovoltaic/thermal systems.

CO4: To be able to model, analyze and design wind energy systems along with biomass based systems.

CO5: To be able to understand and analyze the energy from the ocean wave, Magneto-Hydro-Dynamic Generation and fuel cell.

MODULE 1: Introduction

Fossil fuel based systems, impact of fossil fuel based systems, renewable energy – sources and features, seasonal variations and availability, importance, primary & secondary energy sources, limitations to primary sources, various sources of renewable energy, applications

MODULE 2: Solar Energy Solar Geometry

Solar radiation, solar radiation angles, local solar time, solar radiation spectrum, radiation measurement, solar collector-flat plate collector & solar concentrator, solar heater-water heater & air heater, solar cooker, solar distillation, solar energy storage- sensible heat storage & latent heat storage.

MODULE 3: Solar Photovoltaic Systems

Operating principle, photovoltaic cell concepts, cell, module, array, series and parallel connections, Maximum power point tracking (MPPT)

MODULE 4: Wind Energy

Wind turbine rotor -classification, characteristics, Analysis of ideal wind turbine rotor, Power co-efficient, Types of wind mills, Site selection Characteristics of wind generators

MODULE 5: Biomass

Operating principle, classification, design and applications

MODULE 6: Energy from the Ocean

Tidal energy, wave energy, ocean thermal energy conversion (OTEC) introduction, types, plants & their specifications

MODULE 7: Geo-Thermal Energy

Sources and use of geo-thermal energy, classification of geo-thermal power plants

MODULE 8: Magneto Hydro Dynamic
Generation Principles of MHD generation, MHD generator, equivalent circuits, MHD system

MODULE 9: Fuel Cell
Introduction, energy conversion principles, types of fuel cell, components of a fuel cell, polarization

Textbooks/ Reference Books:

1. Swami Saran, "Soil Dynamics and Machine Foundations", Galgotia Publications Pvt. Ltd., New Delhi.
2. Shamsher Prakesh and Vijay Kumar Puri, "Foundations for Machines: Analysis and Design", A Wiley-Interscience Publication, John Wiley and Sons.
3. P. Srinivasulu and C. V. Vaidyanathan, "Hand Book of Machine Foundations", McGraw-Hill Education.
4. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall International Series, Pearson Education India
5. F. E. Richart, Jr., J. R. Hall, Jr. and R. D. Woods, "Vibrations of Soils and Foundations", Prentice-Hall International Series
6. IS 2974-1: "Code of Practice for Design and Construction of Machine Foundations", Part 1: Foundation for Reciprocating Type Machines, Bureau of Indian Standards

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817PE43	**Advanced Electrical Drives**	**3-0-0**	**3**

Course Outcomes: At the end of this course the student will be able to:

1. Analyze the operation of power electronic converters and their control strategies
2. Analyze the vector control strategies for ac motor drives
3. Implement efficient control strategies for ac motor drives

MODULE 1: Power Converters for AC drives

PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self- commutated devices. Control of CSI, H bridge as a 4-Q drive

MODULE 2: Induction Motor Drives

Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC)

MODULE 3: Synchronous Motor Drives

Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives

MODULE 4: Permanent Magnet Motor Drives

Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM

MODULE 5: Switched Reluctance Motor Drives

Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM

MODULE 6: DSP Based Motion Control

Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control

Textbooks/ Reference Books:

1. P. C. Krause, O. Wasynczuk and S. D. Sudhoff: Analysis of Electric Machinery and Drive Systems, John Wiley & Sons, 2013
2. H. A. Taliyat and S. G. Campbell: DSP based Electromechanical Motion Control‖, CRC press, 2003
3. R. Krishnan: Permanent Magnet Synchronous and Brushless DC motor Drives‖, CRC Press, 2009
4. B. K. Bose: Modern Power Electronics and AC Drives‖, Pearson Education, Asia, 2003

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817OE31	Optoelectronics	3-0-0	3

Course Objectives

- To know the basics of solid-state semiconductor physics and optical fiber wave-guides and understand the nature and characteristics of light.
- To study the performance parameters of optical source and detector and to understand different LED and laser types and their applications.
- To learn the principle of optical detection mechanism in different detection devices.
- To understand different light modulation techniques and the concepts and applications of
- optical switching.
- To become familiar with different optical sensors.

Course Outcomes

CO1: To review solid-state semiconductor physics and optical fiber wave-guides.
CO2: To understand the different types of optical sources, their advantages/disadvantages and applications.
CO3: To able to know the basics of different optical detection devices
CO4: To be able to distinguish among different light modulation techniques and electro optic effects
CO5: To be able to design and development of optical sensors

MODULE 1: Optical Fiber Wave Guides

Theory of Dielectric slab waveguides-Symmetric and Asymmetric slab wave guide, Channel waveguide, Review of ray theory-Electromagnetic mode theory-Phase and group velocity-Modes-guided, radiative and leaky modes-'V' number-cut off wave length-Step index and graded index fibers-Parameters of optical fiber-problems. Signal degradation in fibers-Attenuation-Absorption loss-Linear and nonlinear scattering loss-Fiber bend loss-Dispersion mechanisms-Intramodal and intermodal dispersion-Expressions-modal noise-overall dispersion in single mode/multimode fibers-problems-mode coupling.

MODULE 2: Optical Sources

Light emitting diodes- P N junction characteristics- Direct and Indirect band gap materials-Spontaneous emission- Carrier concentration variation in n+p junction- carrier life time-Diffusion coefficient- Diffusion length- Injection efficiency- internal Quantum efficiency-Power internally generated- Overall efficiency of LED- problems- Heterojunction LEDs – Advantages- LED modulation- Electrical and Optical Bandwidth- LED structures-ELEDs and SLEDs-LED characteristics-Effect of temperature- LED Drive Circuits.

LASER diodes- Spontaneous Vs Stimulated emission-Einstein's relation-population inversion-cavity resonance and threshold gain-Laser modes-stimulated emission in PN junction-Rate equation-condition for lasing-Laser diode characteristics-Modulation-frequency chirp Heterojunction LASER-LASER structures-LED Vs LASER diodes.

MODULE 3: Optical Detectors

Optical Detectors and Fiber optic link, classification of detectors-Photodiodes-PN junction photo diode-PIN photodiode- response and noise- APDs –Advantages of APD- APD Bandwidth and noise-Phototransistor-parameters of phototransistor-problems-Detector performance parameters-noises- NEP

Power launching and coupling- source to fiber coupling-joints- fiber to detector coupling- losses-fiber splicers, connectors and couplers-types-Fiber optic link-System considerations-link power budget-rise time budget-Link Design

MODULE 4: Electro Optic Effects

Birefringence phenomenon EO Retardation, EO Amplitude and Phase Modulator, Electro optic Intensity Modulators, Beam deflection, Acousto-optics, A-O Modulators, Integrated optic spectrum analyzer, Nonlinear optics second harmonic generation, Parametric amplification. Advanced system Technology-Optical Amplifiers-Raman and Erbium doped optical Amplifiers-Noises-Wave Length Division Multiplexing (WDM) and Components-Optical network-wave length routed networks.

MODULE 5: Optical Fiber Sensors

Fiber optic sensors-classification, Multimode fiber Sensors-Displacement, pressure, stress, strain. Intensity modulated sensors, Active multimode FO sensors, Micro-bend optical fiber sensor, Current sensors, Magnetic sensors, Single mode FO sensors, Phase modulated, Polarization modulated, Fiber Optic Gyroscope. Fiber bragg gratings for strain and temperature sensors-displacement sensor-optical computing concepts-optical logic gates.

Textbooks/ Reference Books:

1. B.H Khan, Non-Conventional Energy Sources, Tata Mc Graw Hill Pvt. Ltd.
2. G.D. Rai, Nonconventional energy sources, Khanna publishers
3. S.Hasan Saeed and D.K Sharma, Non-Conventional Energy Resources, Katson Books
4. S.K Dubey and S.K Bhargava, Non-Conventional Energy Resources, Dhanpat Rai & Co.

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817OE32	Computer Vision	3-0-0	3

Prerequisite: Digital Signal Processing as Open Elective-1, Digital Image Processing as Open Elective-2

COURSE OBJECTIVES

- This course is an introduction to the fundamental concepts and techniques in computer vision and their applications to solve real life problems

COURSE OUTCOMES: After completion of the course students will be able to
CO1: analyze mathematical formulation of 3D model image model and its coordinate system
CO2: analyze the algorithms of determining shape and depth of object from its image(s)
CO3: analyze performance of methods of determining shape and depth of object from its image(s)

MODULE 1: Image Formation
Radiometric Properties of Light Sources; Qualitative Radiometry; Sources and their Effects; Point Sources; Line Sources; Area Sources; Gourad & Phong Shading models; Shadows; Ambient Illumination; Photometric Stereo; Normal and Albedo from Many Views; Shape from Normals; Interreflections: Global Shading Models.

MODULE 2: Image Models
Coordinate Systems and Homogeneous Coordinates; Perspective Projection

MODULE 3: Shape from Texture
Representing Texture; Extracting Image Structure with Filter Banks; Analysis (and Synthesis) Using Oriented Pyramids; The Laplacian Pyramid; Shape from Texture: Planes and Isotropy; Recovering the Orientation of a Plane from an Isotropic Texture; Recovering the Orientation of a Plane from a Homogeneity Assumption; Shape from Texture for Curved Surfaces; Shape from Texture

MODULE 4: Geometry of Multiple Views
Two Views; Epipolar Geometry; Three Views; Trifocal Geometry; More than 3 Views; Stereopsis: Reconstruction; Camera Calibration; Image Rectification; Human Vision: Stereopsis; Binocular Fusion; Correlation; Multi-Scale Edge Matching; Dynamic Programming; Using More Cameras; Trinocular Stereo; Multiple-Baseline

MODULE 5: Affine Structure from Motion
Elements of Affine Geometry; Affine Structure from Two Images; The Affine Structure-from-Motion Theorem; Regularization theory; Optical computation; Optical flow; Motion estimation

MODULE 6: Projective Structure from Motion
Motion Estimation from Trifocal Tensors; Motion Estimation from Multiple Views

Textbooks/ Reference Books:

1. Richard Szeliski: Computer Vision: Algorithms and Applications, Springer, 2011
2. David A. Forsyth, Jean Ponce: Computer Vision A Modern Approach, Pearson 2015

3. Manas Kamal Bhuyan: Computer Vision and Image Processing: Fundamentals and Applications, CRC Press, 1st Edition, 2019
4. Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun: A Guide to Convolutional Neural Networks for Computer Vision, Morgan & Claypool Publishers 2018
5. Milan Sonka, Vaclav Hlavac, Roger Boyle: Image Processing Analysis and Machine Vision and MindTap, Cengage India Private Limited; Fourth edition 2017
6. Adrian Kaehler, Gary Bradski: Learning OpenCV 3 - Computer Vision In C++ With The OpenCV Library, Shroff/O'Reilly 2017
7. Miguel Aranda, Gonzalo López-Nicolás, Carlos Sagüés: Control of Multiple Robots Using Vision Sensors, Springer 2017
8. Jan Erik Solem: Programming Computer Vision with Python: Tools and algorithms for analysing images, Shroff/O'Reilly 2012
9. Bernd Jahne, H. Haubecker: Computer Vision and Applications A Guide for Students and Practitioners, Elsevier 2006
10. Richard Hartley, Andrew Zisserman: Multiple View Geometry in Computer Vision, Cambridge University Press 2004
11. Stephan Heuel: Uncertain Projective Geometry: Statistical Reasoning for Polyhedral Object Reconstruction, Springer 2004
12. Berthold Klaus Paul Horn: Robot Vision, MIT Press, McGraw-Hill 1986
13. Dana H. Ballard and Christopher M. Brown: Computer Vision 2ndEd PHI 1982

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817OE33	Electromagnetic Waves	3-0-0	3

COURSE OBJECTIVES

- This course is an introduction to the fundamental concepts of radiation, transmission or propagation and reception of electromagnetic waves

COURSE OUTCOMES: After completion of the course students will be able to

CO1: describe formulation mathematical models of radiation, transmission or propagation and reception of electromagnetic waves

CO2: analyze transmission or propagation of electromagnetic waves through conductor and dielectric media

CO3: analyze radiation from antenna and transmission or propagation of electromagnetic waves through wave guides

MODULE 1: Transmission Lines

Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

MODULE 2: Maxwell's Equations

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

MODULE 3: Uniform Plane Wave

Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

MODULE 4: Plane Waves at Media Interface

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary

MODULE 5: Waveguides

Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic (TM) mode, Cut-off frequency, Phase velocity and dispersion; Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides

MODULE 6 Antennas

Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

Textbooks/ Reference Books:

1. R. K. Shevgaonkar: Electromagnetic Waves, Tata McGraw Hill, 2005
2. D. K. Cheng: Field and Wave Electromagnetics, Addison-Wesley, 1989
3. M. N.O. Sadiku: Elements of Electromagnetics, Oxford University Press, 2007
4. C. A. Balanis: Advanced Engineering Electromagnetics, John Wiley & Sons, 2012
5. C. A. Balanis: Antenna Theory: Analysis and Design, John Wiley & Sons, 2005

Course Code	Course Title	Hours per week L-T-P	Credit C
EE1817OE34	Electrical and Hybrid Vehicles	3-0-0	3

COURSE OBJECTIVES

- This course is an introduction to the fundamental concepts and techniques in Electrical and Hybrid Vehicles for energy efficient transportation systems

COURSE OUTCOMES:

After completion of the course students will be able to

CO1: analyze hybrid vehicles and their performance

CO2: explain the possible ways of energy storage

CO3: analyze the strategies related to energy storage systems

MODULE 1: Fundamentals

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance;

Hybrid Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis

MODULE 2: Electric Trains

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency

MODULE 3: Energy Storage

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices; Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE); Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

MODULE 4: Energy Management Strategies

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV)

Textbooks/ Reference Books:

1. C. Mi, M. A. Masrur and D. W. Gao: Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons, 2011

2. S. Onori, L. Serrao and G. Rizzoni: Hybrid Electric Vehicles: Energy Management Strategies, Springer, 2015
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi: Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2004
4. T. Denton: Electric and Hybrid Vehicles, Routledge, 2016

Course Code	Course Title	Hours per week L-T-P	Credit C
HS181704	**Principles of Management**	**3-0-0**	**3**

MODULE1: Introduction
Definition and meaning of management, Characteristics of management, importance of management, functions of management-planning, organising, directing, staffing, coordination and controlling etc., principles of management, Difference between administration and management

MODULE2: Financial Management
Definition and management of financial planning, importance and characteristics of sound financial plan, concepts of capital- fixed capital and working capital, source of finance, fund flow statement.

MODULE3: Marginal costing
Definition and meaning of marginal costing, advantages, marginal cost equation, contribution, profit-volume ratio, break even analysis, margin of safety.

MODULE4: Cost Accounting
Cost Accounting- Concept and benefit, elements of cost, preparation of cost sheet with adjustment of raw materials, work-in-progress and finished goods.

MODULE5: Capitalisation
Definition and meaning of capitalisation, over and under capitalisation.

MODULE6: Motivation
Introductory observation, definition of motivation, motivational technique, features of sound motivational system.

MODULE7: Leadership
Concept of leadership, principles of leadership, functions of leadership, qualities of leadership, different styles of leadership**.**

Textbooks/Reference Books:

1. Principle of Business Management: RK Sharma, Shashi K.Gupta
2. Business Organisation and Management: SS Sarkar, RK Sharma, Shashi K.Gupta
3. Industrial Organisation and Management: SK Basu, KC Sahu, B Rajviv
4. Principles of Management by Dr. A. K. Bora: Chandra Prakash, Guwahati.
5. Management Accounting: RK Sharma, Shashi K Gupta
6. Cost Accounting: SP Jain, K I Narang
7. Cost Accounting, RSN Pillai, V Bhagawati
8. Principles of Management: RN Gupta
9. Principles of Management: RSN Pillai, S. Kala
10. Principles of Management: Dipak Kumar Bhattacharj

Course Code	Course Title	Hours per week L-T-P	Credit C
EE181722	**Project-1**	**0-0-6**	**3**
GUIDELINES WILL BE ISSUED BY THE UNIVERSITY FROM TIME TO TIME			

Course Code	Course Title	Hours per week L-T-P	Credit C
SI181721	**Internship-III (SAI - Industry)**	**0-0-0**	**2**
GUIDELINES WILL BE ISSUED BY THE UNIVERSITY FROM TIME TO TIME			

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