# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech. Sem III (Electrical Engineering)

## EL410301/EL410301N Engineering Mathematics III

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

After study this subject Expected outcome from the students:

- Can solve the differential Equations and their application in Engineering.
- Can solve Laplace transforms and Z transforms.
- Learn the Fourier analysis and Fourier Transforms.

## Subject Contents

**Unit - 1** **[11]**

**Differential equations and their applications-II:**

Solution of Linear differential equations of higher order with constant coefficients, complimentary function and particular integral, Method of variation of parameters, Method of Undetermined coefficients for solving higher order linear differential equations, Linear differential equations with variable coefficients (Cauchy's and Legendre forms), Simultaneous linear differential equations.

**Unit – 2** **[12]**

**Series solution, Special functions and Partial differential equations with applications:**

Series Solution of Ordinary Differential Equations, Definition and properties of Bessel's and Legendre's functions.

Formation of partial differential equations, Directly integral equations, Lagrange's equation, Solutions of special type of non-linear partial differential equations of the first order, Homogeneous linear equations with constant coefficients, Method of separation of variables, solution of one dimensional wave equation, heat equation and Laplace equation.

**Unit – 3** **[11]**

**Laplace transforms:**
Definition, Linearity property, Laplace transforms of elementary functions, shifting theorem, Inverse Laplace transforms, Laplace transforms of derivatives and integrals, Convolution theorem, Application of Laplace transform in solving ordinary differential equations, Laplace transforms of periodic, Unit step and impulse functions.

**Calculus of Variations:**
Introduction,VariationalProblems, Rayley-Ritz's method, Galerkin method, Euler's Equation, Standard Variational Problems.

**Z-transforms:**
Definition and Standard Z-transforms, Linearity Property, dumping Rule and some standard results, Some useful Z-transforms.

**Unit – 4** **[11]**

**Fourier series, Fourier Integrals and Fourier Transforms:**
Fourier series, Drichlet's conditions, Euler's formula. Fourier expansion of periodic functions, Fourier series of even and odd functions, half range Fourier series, Harmonic analysis.
Fourier integral theorem (only statement), Fourier sine and cosine integrals, Complex form of Fourier integral, Fourier sine and cosine transforms.

**Text books:**


1. Erwin Kreyszig: Advanced Engineering Mathematics (8th Ed.) , Wiley Eastern Ltd., New Delhi.
2. Merel C Potter,J L Goldberg: Advanced Engineering Mathematics (3rd Ed.),Oxford India Publication.


**Reference Books:**


1. B. V. Ramana: Higher Engineering Mathematics, McGraw Hill, New Delhi.
2. Dr. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi.
3. R K Jain, S R K Iyengar: Advanced Engineering Mathematics. Third Edition, Narosa Publishing House
4. Murray Spiegel: Advanced Mathematics for Engineering & Science: (Schaum's Outline Series),Tata – McGraw Hill Publication


- **Question Paper Pattern :**

  Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech. Sem III (Electrical Engineering)

## EL410302/EL410302N/EL410311 Network Analysis

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Learn the different theorem to solve the network.
- Analysis the circuit containing dependent and independent sources.
- Time domain response of linear circuit.
- Laplace transforms analysis and Circuit application.
- Also learn two port networks.

## Subject Content

**Unit – 1** **[15]**

**Introduction:**
Electromotive force, potential, voltage, current, Resistor, capacitor, inductor voltage and current sources, Dependent sources, Dual circuits, Dot conventions, Current directions

**Network Equations**
Nodal analysis, Mesh analysis, Source transformation, Analysis of circuit containing dependent sources, Superposition theorem, Substitution Theorem, Compensation theorem, Thevenin's and Norton's theorem, Maximum power transfer theorem, Reciprocity and Millman's theorem

**Unit – 2** **[11]**

**Time domain response of linear circuits**
Mathematical preliminaries, DC response of first order and second order circuits**,** Initial and final conditions in the network**,** Charging and discharging of capacitor, Charging and discharging of inductor, Solution of circuit equations by using Initial and Final Conditions

**Unit – 3** **[11]**

**Laplace transforms analysis: Circuit Applications:**
Manipulation of impedance and admittance, Equivalent Laplace transform of circuit elements, RLC circuit analysis using Laplace transform, Switching in RLC circuit, Transforms of signal waveforms, Circuit analysis in Laplace transform

**Unit – 4** **[08]**

**Two Port Network:**
Y- Parameter**,** z-Parameter**,** h-parameter**,** ABCD-parameter**,** Relation between two port parameters**,** Series and Parallel connection of two port network

**Text Books:**


1) Network Analysis, M E Van Valkenburg, PHI
2) Circuit Theory- Analysis and Synthesis, A Chakrabarti, DhanpatRai Publications
3) Electric Circuits and Networks :- By K. S. Suresh Kumar – Pearson Education


**Reference Books:**


1) Linear Circuits Analysis 2nd edition :- By DeCarlo/ Lin – Oxford University Press (Indian edition)
2) Engineering Circuit Analysis : - By W H Hayt, J E Kemmerly, S M Durbin 6th Edition TMH Publication
3) Network Analysis & Synthesis By Franklin S. KUO, Wiley Publication


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech. Sem III (Electrical Engineering)

## EL410303/EL410303N/EL410312 Fundamentals of Power Systems

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Learn the component of power system. Generation, Transmission and Distribution.
- Learn the different Power Plant, efficiency, environmental aspects etc.
- Also know the Mechanical aspects, supply system, classification of substation and earthing concept.

## Subject Contents

**Unit – 1** **[11]**

**Introduction:**

Power system basics, single line diagram of power system, components of power system

**Electrical Power Generation:**

Common types of power plants: thermal, hydro, nuclear, combined cycle power plants. basic layout and schematic arrangement, advantages and disadvantages, choice of site, efficiency of power plants, characteristic, environmental aspects for selecting sites and locations of power stations.

**Unit – 2** **[11]**

**Substation:**

Classification, types, comparison of indoor and outdoor substations, pole mounted substation, site selection, various components and their symbols, bus bar arrangements, key diagrams, function of various substation equipment, substation auxiliaries-PLCC; battery room; control room etc.

**Supply System:**

Electric supply system, typical AC & DC power supply system, comparison between overhead and underground supply system, effect of voltage on the size of the feeder, radial , parallel and ring main distribution system.

**Unit – 3** **[12]**

**Mechanical Aspects of Overhead Lines:**

Main components of overhead lines, line supports, cross arms, conductors, materials; types; configurations, insulators, dampers, v guards, guard wires, danger plates, barbed wires, continuous earthed wires, overview of Indian Electricity Rules. Overhead insulators – materials,

Types, causes of failure of insulators, potential distribution over a string of suspension insulators, string efficiency, methods of improvement of string efficiency. Calculation of Sag and Tension – unequal support, ice effect & wind effect on sag, stringing charts.

**Unit – 4** **[11]**

**Line Constants:**

Resistance of line, Inductance of conductor due to internal and external flux, Inductance of 1-phase, two-wire line and composite conductor lines, self GMD, mutual GMD, inductance of 3-phase line with equal and different spacing, with and without transposition, double circuit line and bundled conductors, capacitance of 1-phase and 3-phase transmission line, Effect of earth on transmission line capacitance, capacitance of double circuits with symmetrical and unsymmetrical spacing, transposition, skin effect, proximity effect

**Earthing:**

Neutral earthing – necessity; methods; comparison, earthed transformer for artificial earthing, tower earthing. Equipment earthing – necessity and methods.

**Text Books:**


**1)** A Course in Electrical Power, Soni, Gupta, Bhatnagar&Chkraborty, DhanpatRai Pub.
**2)** Electrical Power, J. B. Gupta S. K. Kataria


**Reference Books:**


1) Electrical Power system, C.L.Wadhva New Age Publication
2) Electrical Power System, V. K. Mehta S. Chand Publication
3) Power Station Engineering, Nagarath & Kothari TMH Publication


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit

# INDUS UNIVERSITY
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## Department of Electrical Engineering

### B.Tech. Sem III (Electrical Engineering)

## EL410304/EL410304N/EL410313 Transformers & D.C. Machine

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Learn the D.C. Machines construction, working principle and performance.
- Also Learn the single Phase and poly phase transformer types, operation and constructions.

## Subject Contents

**Unit – 1** **[11]**

**D.C. Generator:**
Principle of D.C. generator and motor, construction, types of generators, E.M.F. equation, and voltage build up process, critical resistance and speed, characteristics of generators, performance equation and efficiency, No load & load characteristics, Performance of shunt, series and compound generators.

**Unit – 2** **[12]**

**DC Motor:**
Type of motors, torque equation, characteristics, losses and efficiency, starters: Necessity of starter, Three point & four point starter, Introduction to soft starter, Torque-speed characteristics of shunt, series & compound motors, Speed control, Basic concept of Static speed control of DC machines, Ward Leonard method. Losses & efficiency in DC machines by direct load test and Swinburne test.

**Unit – 3** **[11]**

**Single Phase Transformer:**
Construction and principle of single-phase transformer, operation at no load and on load, vector diagram, equivalent circuit, losses, efficiency and regulation, determination of regulation and efficiency by direct load test and indirect test methods, parallel operation, auto transformer, condition for maximum efficiency, all day efficiency.

**Unit – 4** **[11]**

**Poly-phase Transformer:**
Polarity, Star/star, Star/delta, Delta/delta, delta/zigzag, terminal marking, Nomenclature, Vector diagram, Phase groups, Parallel operation, Scott connection, V-V connections tertiary winding, Testing of transformers, Sumpner's test - efficiency - transients in transformers - voltage regulation - off load and on load tap changers, Concept of Welding transformer, Rectifier transformer & High frequency transformer.

**Text Books:**


1) "I J Nagrath and D P Kothari, "Electrical Machines", Tata McGraw Hill Publishing Company Limited New Delhi, 3rd Edition, 2007.
2) Fitzgerald, Kingsley and Umans, "Electric Machinery":, TMH, New Delhi


**Reference Books:**


**1)** A K Theraja & B L Thereja, "A Text book of Electrical Technology ( Vol II)", S Chand & Co- 23rd Edition 2008.
**2)** R.K.Rajput, "Electrical Machine", Laxmi Publications, 5th Edition 2008.
**3)** J.B. Gupta, "Theory and Performance of Electrical Machines", S.K.Kataria and Sons, Reprint 2010 S
**4)** K Sen, "Electrical Machinery", Khanna Publishers, New Delhi, Reprint 2002


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
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## Department of Electrical Engineering

### B.Tech. Sem III (Electrical Engineering)

## EL410305/EL410305N Electronics Devices & Circuit

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- To make the students aware about the analog devices characteristics and its various applications in the field of Electrical and Electronics Engineering.
- Learn Transistor, FET and BJT.
- Also they learn OPAMP and its application in this subject.

## Subject Contents

**Unit – 1** **[10]**

**Transistor Biasing and Thermal Stabilization:**
Operating point, Bias Stability, Self-Bias, Stabilization against Variations in ICO, $V_{BE}$ and beta, General Remarks on Collector-Current Stability, Bias Compensation, Thermistor and Sensistor Compensation, Thermal Runaway, Thermal Stability.

**Unit – 2** **[14]**

**Transistor at Low Frequencies:**
Graphical Analysis of the CE configuration, Two-Port Devices and the Hybrid Model, Transistor Hybrid Model, h-Parameters, Conversion Formulas for the Parameters of Three Transistor Configurations, Analysis of a Transistor Amplifier Circuit Using h Parameters, Emitter Follower, Comparison of Transistor Amplifier Configurations, Linear Analysis of a Transistor Circuit, Miller's Theorem and its Dual, Cascading Transistor Amplifiers, Simplified CE Hybrid Model, Simplified Calculations for the CC Configuration, CE Amplifier with an Emitter Resistance.

**Unit – 3** **[11]**
**Power Amplifier:**
Class A large Signal Amplifiers, Second Harmonic Distortion, Higher Order Harmonic Generation, Transformer Coupled Audio Power Amplifier, Efficiency, Push-Pull Amplifiers, Class B Amplifiers, Class AB Operation.

**Field Effect Transistors:**
Junction FET, Pinch-Off Voltage, JFET Volt-Ampere Characteristics, FET Small-Signal Model, MOSFET, Low Frequency CS and CD Amplifiers, Biasing the FET, the FET as a Voltage Variable Resistor.

**Unit – 4** **[10]**

**OPAMP:**
Differential amplifier, open and closed loop gain of OPAMP, Op amp Parameters, slew rate, offset voltage, offset balancing technique, etc., inverting amplifier, non-inverting amplifier, frequency response, frequency compensation techniques

**OPAMP Applications:**
OPAMP as adder, subtractor, integrator, differentiator, voltage follower, constant voltage source, constant current source, comparator, zero crossing detector, Schmittz' trigger, Multivibrators Based on 555, Design of regulated power supplies.

**Text Books:**
1. Electronics Devices and circuits by Millman and Halkias
2. Electronics Device and Circuit Theory by Robert L. boylestad and Louis Nashelsky, Pearson Education.
3. OP-AMPs and Linear Integrated Circuits by Ramakant A. Gayakwad, Prentice Hall.

**Reference Books:**
1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Tata McGraw-Hill 2009 Edition.
2. Salivahanan, S., "Linear Integrated Circuits", Tata McGraw-Hill, 2008.

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# INDUS UNIVERSITY
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## Department of Electrical Engineering

## B.Tech. Sem III (Electrical Engineering)

## EL410306/EL410306N/EL410314 Electrical and Electronics Measurement and Measuring Instruments

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 60 | 00 | 00 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Learn the measurement of various electrical and electronics parameter in this subject.
- Learn Measuring equipment, accuracy, range and other parameter of the Meter.

## Subject Contents

**Unit – 1** **[15]**

**Measurements:**
Methods of measurement, Measurement system, Classification of instruments, Definition of accuracy, precision, resolution. Speed of response. Errors in measurement, classification of errors. Loading effect due to shunt and series connected instruments.

**Analog meter:**
General features, Construction, principle of operation and torque equation of moving coil, moving iron, electrodynamometer, Induction, and Electrostatic type instruments. Principle of operation of the thermoelectric, rectifier type instruments.

**Extension of instrument range:**
Shunt, multipliers. Disadvantages of shunt & multipliers.

**Unit – 2** **[15]**

**Instrument transformer:**
Advantages of Instrument Transformers, Principle of operation of current & potential transformer, errors.

**Measurement of resistance:**
Measurement of medium resistance, low, and high resistances. Megger.

**Potentiometers:**
Principle of operation and application of Crompton's DC potentiometer, Polar and coordinate type of AC potentiometers.

**Unit – 3** **[15]**

**AC bridges:**

Measurement of inductances, Capacitance and frequency by A.C bridges.

**Measurement of power:**

Principle of operation of Electrodynamics & induction type wattmeter, wattmeter errors.

**Measurement of energy:**

Construction, theory and operation of AC energy meter, testing of Energy meters.

**Cathode Ray Oscilloscope:**

Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO, Sampling and storage oscilloscope. Double beam CRO

**Unit – 4** **[15]**

**Electronic instruments:**

Advantages of digital meters over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, signal generator, LCD and LED displays, Function generators.

**Sensors & Transducers:**

Introduction to sensors & transducers, strain gauge, LVDT, temperature transducers, Flow measurement using magnetic flow measurement.

**Accessories for Measuring Instruments:**

Probes, Test leads, shielded cables, connectors, use of probes, low capacitance probes, High voltage probes, RF demodulator probes, probes for ICs, Current probes

**Text Books:**


1) "Electrical and Electronic Measurements and Instrumentation", A. K. Sawhney, Dhanpatrai and Sons, New Delhi.
2) "Modern Electronic Instrumentation and Measuring Techniques", Cooper D. and A.D. Heifrick, P.H.I.


**References Books:**


1) "Electrical Measurements and Measuring Instruments", Golding and Widdies, Pitman.
2) "Electronic Instrumentation and Measurement", David A. Bell, 2nd Edition, P.H.I., 2006.
3) "Electric Measurements", Harris, John Wiley.


**Question Paper Pattern:**

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**INDUS UNIVERSITY**
**INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING**
**Department of Electrical Engineering**

**B.Tech. Sem III (Electrical Engineering)**

# EL410307 Transformers & DC Machine Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiments List

| Sr. No. | Name of Experiment |
|---|---|
| 1. | To Perform Transformer Ratio Test & Polarity Test of Single Phase Transformer |
| 2. | To Perform Open Circuit & Short Circuit test of Single Phase Transformer. |
| 3. | To Perform Direct Load Test on Single Phase Transformer |
| 4. | To Perform Parallel Operation of Single Phase Transformer |
| 5. | To Study of Different Connection of 3 Phase Transformer |
| 6. | To Perform Open Circuit & Short Circuit test On Three Phase Transformer |
| 7 | To Perform Direct Load test of 3- Phase transformer |
| 8. | To Study D.C. Machines Component & D.C. Starter. |
| 9. | To Perform Open Circuit characteristics & Load Characteristic of a D.C. Shunt Generator |
| 10. | To Perform Load test on a D.C. Series Generator to obtain its characteristics |
| 11. | To Perform Speed Control of D.C. Shunt Motor |
| 12. | To Perform Speed Control of D.C. Series Motor |
| 13. | To Predetermine the efficiency of a DC shunt machine by conducting the Swinburne's Test. (1) as a motor (2) as a generator |
| 14. | To Conduct the Hopkinson's test on the pair of DC machines |

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**Department of Electrical Engineering**

**B.TechSem III (Electrical Engineering)**

# EL410308 Electronics Device & Circuit Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiments List

| Sr. No. | Name of Experiment |
|---|---|
| 1. | To Design voltage divider biasing circuit for a given transistor. |
| 2. | To Plot frequency response of CE amplifier. |
| 3. | To plot the characteristics of FET. |
| 4. | To plot characteristics of Push-Pull amplifier. |
| 5. | To verify OPAMP Characteristics. |
| 6. | To perform Inverting and Non inverting amplifier. |
| 7. | To Perform OPAMP as Summing and Differential amplifier. |
| 8. | To Perform OPAMP as a comparator. |
| 9. | To perform OPAMP as a Schmitt trigger. |
| 10. | To verify Astable, Monostable and Bistable multi-vibrator using IC 555. |
| 11. | Design Regulated power supply |

**INDUS UNIVERSITY**

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**Department of Electrical Engineering**

**B.Tech. Sem III (Electrical Engineering)**

# EL410309 Electrical & Electronics Measurement & Measuring Instruments Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| **Class Room Contact Hrs** | **Practical** | **Activity Based Learning** | **Credits** | **University Examination** | **Mid Sem Examination** | **Continuous Evaluation** | **Total Marks** |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiments List

| Sr. No. | Name of Experiment |
|---|---|
| 1. | To study the Cathode Ray Oscilloscope (CRO) |
| 2. | Measurement of low resistance using Kelvin bridge |
| 3. | Measurement of inductance using Maxwell bridge |
| 4. | Measurement of capacitance using Schering bridge |
| 5. | To Study Characteristics of LVDT or Displacement Transducers |
| 6. | Measurement of strain and linear range of operation using Strain Gauge transducer |
| 7. | Characteristics of Thermocouple temperature transducer. |
| 8. | To find the characteristics of thermocouple and to measure the temperature using thermocouple. |
| 9. | Proximity sensor and its applications |
| 10. | Analyze analog and digital multi-meter for various measurements. |
| 11. | Demonstrate functionality of function generator and its use as a test and measurement equipment. |

**INDUS UNIVERSITY**
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**Department of Electrical Engineering**

**B.Tech. Sem III (Electrical Engineering)**

# EL410310 Network Analysis Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiments List

| Sr. No. | Name of Experiment |
|---|---|
| 1. | To verify KVL and KCL Theorem. |
| 2. | To verify Superposition Theorem. |
| 3. | To verify Thevenin and Norton Theorem. |
| 4. | To verify Maximum Power Transfer Theorem. |
| 5. | To verify Substitution and Reciprocity Theorem. |
| 6. | To perform RC charging and Discharging and find out Time constant. |
| 7. | To perform RL charging and Discharging and find out Time constant. |
| 8. | To verify the time response characteristic of second order system. |
| 9. | To verify Two Port Network Circuit. |
| 10. | To verify mesh analysis and Nodal analysis of AC circuit using Multisim |

# INDUS UNIVERSITY
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## Department of Electrical Engineering

### B.Tech.Sem IV (Electrical Engineering)

## EL410401/EL410401N Numerical Methods & Optimization Techniques

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 60 | 00 | 00 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Introduces important algorithms and techniques of scientific computing, focusing on the area of numerical optimization.
- The course will present both theoretical and practical aspects of the algorithms.
- Develop skill of Numerical Computation.

## Subject Contents

**Unit 1.** **[15]**

**Introduction to Numerical Methods:**
Why study numerical methods. Sources of error in numerical solutions: truncation error, round off error. Order of accuracy - Taylor series expansion.

Direct Solution and Iterative solution of Linear systems:
Gauss elimination, Gauss Jordan elimination. Pivoting, inaccuracies due to pivoting. Factorization, Cholesky decomposition. Diagonal dominance, condition number, ill conditioned matrices, singularity and singular value decomposition. Banded matrices, storage schemes for banded matrices, skyline solver. Jacobi iteration. Gauss Seidel iteration. Convergence criteria.

**Unit 2** **[15]**

Direct Solution and Iterative solution of Non Linear systems: Newton Raphson iterations to find roots of a 1D nonlinear equation. Generalization to multiple dimensions. Newton Iterations, Quasi Newton iterations. Local and global minimum, rates of convergence, convergence criteria. Conjugate gradient Preconditioning.

**Unit 3** **[15]**

**Numerical Differentiation:**

Difference operators (forward, backward and central difference). Stability and accuracy of solutions. Application of finite difference operators to solve initial and boundary value problems.

Introduction to the Finite Element Method as a method to solve partial differential equations: Strong form of the differential equation. Weak form. Galerkin method: the finite element approximation. Interpolation functions: smoothness, continuity, completeness, and Lagrange polynomials. Numerical quadrature: Trapezoidal rule, Simpsons rule, Gauss quadrature.

**Unit – 4** [15]

**Optimization:**

Engineering applications of optimization, Design variables, constraints, objective function, variable bounds, statement and formulation of an optimization problem, Examples of Electrical Engg. Optimization problems, classification of optimization problems, different optimization algorithms.

Optimal point:
Local optimal point, global optimal point and inflection point.
Single variable optimization techniques:
- Optimality criterion.
- Bracketing method (Bounding Phase Method).
- Region elimation methods (Internal halving method, Golden section search method).
- Point estimation method (successive quadratic estimation methods).
- Gradient-based methods (Newton-Raphson method, Bisection method, Secant, Cubic search method).
- Root finding using optimization techniques.

**Reference books:**


1. Numerical Methods in Engg. & Sc. by B.S. Grewal (Khanna Publishers)
2. Engg. Optimization by S.S.Rao (New Age).
3. Optimization: Theory & Practice by Beveridge & Schecter, (McGraw Hill).


**Question Paper Pattern:**

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# INDUS UNIVERSITY
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## Department of Electrical Engineering

## B.Tech. Sem IV (Electrical Engineering)

## EL410402/EL410402N Electromagnetics

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| **Class Room Contact Hrs** | **Practical** | **Activity Based Learning** | **Credits** | **University Examination** | **Mid Sem Examination** | **Continuous Evaluation** | **Total Marks** |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Getting the basic knowledge of different electromagnetic laws.
- Maxwell's equations in different form, boundary conditions and retarded potentials can be understood.
- Understand the conceptual as well as mathematical analysis of the waves.
- The waves inside the transmission line and important parameters are described.
- Wave propagation concept inside the waveguide is understood.

## Subject Contents

**Unit – 1** **[12]**

**Vector analysis:** Vector Algebra, Dot Product, Cross Product, Cartesian coordinate system, Vector Components and Unit Vectors, Circular Cylindrical Coordinates, The Spherical Coordinate System.
**Electrostatics:** Coulomb's law and electric field intensity-Electric fields due to continuous Charge distribution-Field due to different configurations of charges: Point charges, line charges, surface charges, volume charges.

**Unit – 2** **[12]**

**Electric flux density, Gauss's law & Divergence:**
Electric flux density-Gauss law- Maxwell's equations (electrostatics)- application of Gauss law-Divergence, divergence theorem-Electric potential and potential difference-Gradient, relation between field intensity and electric potential, conservative field
**Energy and Potential**:

Energy and Potential in a Moving Point Charge in an Electric Field, Line Integral, Potential Difference and Potential, Potential Field of a Point Charge, Potential Field of a System of Charges: Conservative Property, Potential Gradient, Dipole.

**Unit – 3** **[11]**

**Conductors, Dielectrics, and Capacitance:**
Current and Current Density, Continuity of Current, Conductor Properties and Boundary Conditions, Nature of Dielectric Materials, Boundary Conditions for Perfect Dielectric Materials, Capacitance, Several Capacitance Examples,
Poisson's and Laplace's Equations.

**Magnetostatics: The Steady Magnetic Field**: Biot-Savart Law, Ampere's Circuital Law, Curl, Stokes' Theorem, Magnetic Flux and Magnetic Flux Density

**Unit – 4** **[10]**

**Magnetic Forces, Magnetic Materials:**
Force on a Moving Charge, Lorentz force equation, Force on a Differential Current Element, Force between Differential Current Elements, Force and Torque on a Closed Circuit, Nature of Magnetic Materials, Permeability, and Magnetic Boundary Conditions. Inductance and mutual inductance

**Time varying fields & Maxwell's Equations:** Faraday's Law, Displacement Current, Maxwell's Equations in Point Form, Maxwell's Equations in Integral Form, Retarded Potentials.

**Text Book:**


1. William H Hayt ,Jr. Jhon H. Buck, "Engineering Electromagnetic" Tata-McGraw-Hill, 2001.
2. Elements of Electromagnetic, Mathew N.O. Sadiku, 4th edition, Oxford university press.
3. R. F. Harrington," Time harmonics Electromagnetic fields" IEEE Press Series, 2001.


**Reference Book:**


1. Electronic and Radio Engineering – F.E. Terman, McGraw-Hill, 4th edition, 1955.
2. Ramo, S., Whinnery J.R., and van Duzer, T: fields and Waves in Communication Electronics, 3rd ed., Wiley Eastern


**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B. Tech. Sem IV (Electrical Engineering)

## EL410403/EL410403N/EL410412 Control Engineering

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- To learn the basic concepts of linear control theory and its analysis.
- Different system representation, block diagram reduction and Mason's rule.
- Time response analysis of LTI systems and steady state error.
- The open loop and closed loop frequency responses of systems.
- Stability concept using bode plot, routh- hurwtiz stability criterion and root locus.
- Frequency domain

## Subject Contents

**Unit – 1** **[15]**

**Introduction**

Introduction, Open-loop system and its examples, Closed-loop system and its examples, Open-loop vs Closed-loop

**Mathematical Modeling**

Modeling of Mechanical system, Modeling of Electronic and electrical system, Modeling of Liquid-level system, Transfer function of system, Modeling in state-space

**Unit – 2** **[10]**

**Block diagram and Signal Flow graph**

Block diagram formulation, Block diagram reduction, Signal Flow graph, Mason's Gain formula

**Transient and steady-state response analysis**

First-order and second order systems, higher order systems Transient response of system

**Unit – 3** **[17]**

**Transient and steady-state response analysis**

Steady-state error, RH stability criteria, Effect of Proportional, derivative and integral control, MATLAB simulations

**Root-locus Analysis**

Introduction, Rules for constructing the root locus, System analysis with the help of Root-locus Root- locus plot using MATLAB.

**Unit – 4** **[18]**

**Frequency Response Analysis**

Introduction, Specification for frequency response, Polar-plots, Bode plots, Nyquist plots, Stability analysis, MATLAB simulations

**Control systems and components**

Comparison between ordinary motor and servo motor, T.F. of servo motors: Field controlled D.C. servo Motor, Armature controlled D.C. servo motor, two phase A.C. servo motor, Introduction to stepper motors & its applications.

**Text Book:**

1. Modern Control Engineering by Katsuhiko Ogata, 4th Edition, Prentice Hall of India
2. Automatic Control Systems by Benjamin C.Kuo, John Wiley & Sons

**Reference Book:**

1. Control system Engineering, Forth Edition, Norman S Nise, Wiley-India Edition
2. Control system Engineering, Fifth Edition, I J Nagrath, M Gopals

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech.Sem IV (Electrical Engineering)

# EL410404/EL410404N/EL410414 Digital Electronics

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Learning Objectives:**

- Get familiar with digital World. Learn the Number System, Boolean algebra.
- Combinational and Sequential Circuits.
- Develop the logical skill from this subject.

## Subject Contents

### UNIT-1

**Binary Number** **[11]**

- Introduction to Digital and Analog System
- Octal, Decimal and Hexadecimal Numbering System
- Binary Numbering System
- Binary Conversion
- Binary Operation
- Gray Code, BCD code, Excess Three code

**Boolean Algebra**

- Axioms and Laws of Boolean Algebra
- De Morgan's Theorem
- Duality and Dual
- Simplification of Boolean algebra using K-map and Tabulation method

### UNIT -2

**Logic Gates** **[11]**

- Basic Gates like AND, OR, NOT
- Universal gates (NAND, NOR)
- X-OR, X-NOR and BUFFER
- Logic Operations
- NAND and NOR implementation

- Sum of product and product of sum representation

**Logic Families**

- Introduction
- Noise Margins
- Fan-in and Fan-out
- RTL and DTL logic
- Integrated-Injection Logic
- Emitter-Coupled Logic
- Complementary MOS

## UNIT-3

**Combinational Logic** **[12]**

- Introduction
- Code Conversion
- Multilevel NAND and NOR circuit
- Various types of Adders and Subtractors
- Magnitude Comparator
- Decoders / Encoders
- Multiplexers / Demultiplexer
- Programmable Logic Array

**Sequential Logic**

- Introduction
- Flip-Flops
- Triggering of Flip-Flops
- Conversion of Flip-Flops

## UNIT – 4

**FSM, Counter and Shifters Design** **[11]**

- FSM Design
- Ripple Counter(Asynchronous Counter)
- Synchronous Counter
- Serial-in, Serial-out Shift Register
- Parallel-in, Serial -out Shift Register
- Serial-in, Parallel-out Shift Register
- Parallel-in, Parallel-out Shift Register
  Universal Shift Register(Barrel Shifter

**Textbooks:**

1. Digital Logics and computer design Electronics by Morris Mano PHI Publication

**Reference books:**

1. Morden Digital Electronics by R.P.Jain , Khann Publication
2. Digital Electronics by Anand Kumar, PHI Publication

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech Sem IV (Electrical Engineering)

## EL410405/EL410405N/EL410415 Asynchronous Machines

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Learning Objectives:**

- To learn the principle, construction, performance and operation of Three Phase Induction Motor, Generator.
- Learn the types of Single Phase A.C. Motors. Also Principle and operation of the Single Phase A.C. Motor.
- Also know the action of Commutator motor as Frequency converter, Principle and construction.

## Subject Contents

### UNIT-I

**Three Phase Induction Motor:** **[12]**

Introduction, Construction and working principle, Rotating Magnetic Field due to 3-phase currents, Slip, Rotor current Frequency, Rotor Torque, Starting Torque, Condition for Maximum Starting Torque, Torque-slip characteristics Various methods of measurement of slip, Plugging of an Induction Motor, Braking, Induction Motor, Induction Generator, Application of Induction Generators, Analogy of an I.M. to a transformer, Equivalent Circuit model of an Induction Motor, Starting of Induction Motor.

### UNIT-II

**Three Phase Induction Motor:** **[11]**

No-load & blocked rotor test, Circle diagram, Efficiency and slip scale with the help of circle diagram Effect of rotor resistance on performance of I.M., Double cage squirrel cage IM and its equivalent circuit, Induction machine dynamics, Speed control of 3- phase I.M., Electrical transients in induction machine, Magnetic levitations, Effect of harmonics, Harmonic torques, Cogging & Crawling, Advantages & application of linear induction motor.

## UNIT-III

**Single phase A. C. motors:** **[11]**

Introduction, production of rotating magnetic field, Double-Revolving-Field theory of single phase Induction motors, Equivalent Circuit, Types of single phase motors, Principle and operation of split phase, Resistance start, Capacitor start and capacitor start & run induction motor, Shaded pole induction motor, comparison between Single-phase and three phase Induction Motor.

## UNIT-IV

**Commutator motors:** **[11]**

Action of commutator as a frequency converter, Construction and principles of following commutator motors: Single Phase Repulsion Start induction-Run motor, Repulsion-induction Motor, Schrage motor, AC series motor or Universal motor.

**Textbooks:**

1. Electrical Machines by Nagrath & Kothari, TMH Publication

**Reference books:**

1. Performance and Design of A C machines by M G Say, CBS
2. Electrical Machinery by P S Bhimbhra, Khanna Publication
3. Electrical Machines by Chakravorti & Mukharaji, DhanpatRai Publication

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech. Sem. IV (Electrical Engineering)

## EL410406/EL410406N/EL410416 Performance of Power System

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Learn the Power System Transmission and Distribution System Its Parameter.
- Performance of the Transmission Line component, Interference.
- Learn Economic consideration, Power Factor Correction and Tariff.

## SUBJECT CONTENTS

### UNIT – 1

**Performance of Transmission Line:** **[12]**

Classification, regulation and efficiency, generalized constant, short transmission line performance methods, medium transmission line performance by nominal T- method, nominal Π etc. methods. Rigorous solution, ABCD constant for long transmission line, surge impedance, SIL.

### UNIT – 2

**Variable Load On Power Stations:** **[11]**

Structure of electric power system, Variable load on power station, load curves, Important terms and factors, types of loads, interconnected grid system.

**Economics Of Power Generation & Tariff:**

Introduction cost of electrical energy, Methods of Determining depreciation. Tariff and its types. Desirable characteristics of a Tariff, Types of consumers and their tariffs.

**Power Factor Improvement:** Consideration of effect of low power factor, Advantages of power factor improvement, methods of improving power factor, the most economical power factor

## UNIT – 3

**Distribution System** **[11]**

Classification of Distribution System, Overheard versus Underground system, Requirements of distribution system, design consideration in distribution system, Types of D.C distribution system, D.C distribution calculation, A.C. distribution calculation, Methods of solving A.C. Distribution problems

## UNIT – 4

**Underground Cable:** **[11]**

Types and classification, constructional features, insulation stress, sheathing, capacitance grading, capacitance of 3-core cable, thermal characteristic, selection of cable, cable laying methods, cable testing.

**Corona And Radio Interference:**

Phenomenon, electric stress, terms associated with corona, power loss, factors affecting corona interference with neighboring communication circuits, corona aspect in transmission line, HVAC/HVDC, electromagnetic effect and electrostatic effect

**Textbooks:**

1. Modern Power System Analysis by I. J. Nagrath & D. P. Kothari, TMH Publication.
2. Power System analysis and Design by B.R.Gupta, Wheeler

**Reference books:**

1. Element of Power System Analysis by W. D. Stevenson, TMH Publication
2. A Course in Electrical Power by Soni, Gupta, Chakraboti and Bhatnagar,DhanpatRai.
3. Electrical power system by C.L.Wadhva, New Age Publication
4. Power system Engineering by I. J. Nagrath& D. P. Kothari, TMH Publication
5. Power System Analysis by Hadi Sadat, TMH Publication

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech. Sem IV (Electrical Engineering)

# EL410407 Digital Electronics Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| **Class Room Contact Hrs** | **Practical** | **Activity Based Learning** | **Credits** | **University Examination** | **Mid Sem Examination** | **Continuous Evaluation** | **Total Marks** |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

## Laboratory Experiment List

| Sr. | Index |
|---|---|
| 1. | Verification of various types of logic gates and its truth table. |
| 2. | Verification of DeMorgan's Theorems. |
| 3. | Verification of NAND and NOR gates as universal gates. |
| 4. | Design of half adder and full adder and verification of their truth table. |
| 5. | Design of Half Subtractor and Full Subtractor and verification of their truth table. |
| 6. | Verification of different Types of Flip-Flops And Their Truth Table. |
| 7. | Design Logic Circuit for Conversion of BCD to Seven Segment Number. |
| 8. | Design Logic Circuit for 8 X 1 multiplexer and 1 X 8 demultiplexer. |
| 9. | Design Logic Circuit for Shift register. |
| 10. | Design Logic Circuit for Counter. |
| 11. | Design Logic Circuit for 4 bit Binary-to-Gray Code Converter. |

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech. Sem IV (Electrical Engineering)

## EL410408 Asynchronous Machines Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

### Laboratory Experiment List

| Sr. | Index |
|---|---|
| 1. | Three phase induction motor components |
| 2. | To study the different types of motor starters. |
| 3. | Star-Delta starter operation of three phase induction motor |
| 4. | No load & blocked rotor test on 3-phase induction motor |
| 5. | Brake test on 3-phase slip ring induction motor |
| 6. | Load test on 3-phase slip ring induction motor |
| 7 | No load and blocked rotor test on 1-phase induction |
| 8. | To study the speed control of repulsion motor by variations of brush positions. |
| 9. | To determined speed control of universal motor. |
| 10. | To study the construction and working principle of a commutator motor. |
| 11. | Pole changing method for three phase induction motor |
| 12. | To test a three phase squirrel cage induction motor with the help of megger. |
| 13. | To identify the terminals of a three phase squirrel cage induction motor using voltmeter method. |

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B. Tech. Sem IV (Electrical Engineering)

## EL410409 Performance of Power System Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

### Laboratory Experiment List

| Sr. No. | Title |
|---|---|
| 1. | Study of various electrical power generating stations |
| 2. | To study different types of Tariffs and Electricity bill. |
| 3. | To measure characteristics of transmission line |
| 4. | To measure attenuation of transmission line |
| 5. | To measure input impedance of the transmission line |
| 6. | To plot phase displacement between the current and voltage at input of the line |
| 7. | To improve power factor and its control |
| 8. | To study the classification of overhead transmission lines and measure voltage regulation and efficiency of the lines |
| 9. | To Study medium transmission line model and to obtain the performance calculation of different methods used in medium transmission lines. |
| 10. | To measure ABCD constants for transmission lines |
| 11. | Study of cables and their internal construction |
| 12. | To study and obtain the performance calculations of Ferranti Effect in power system. |
| 13. | To study shunt compensation method. |

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech.Sem IV (Electrical Engineering)

## EL410413 Control Engineering Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

### Laboratory Experiment List

| Sr. | Index |
|---|---|
| 1. | To verify the operation of Open loop control system. |
| 2. | To verify the operation of Type "0" Control System. |
| 3. | To verify the operation of Type "1" Control System. |
| 4. | To verify the operation of Type "2" Control System. |
| 5. | Introduction of Control System Toolbox commands and obtained the first order and second order response for the different inputs. |
| 6. | Feedback system simulation in MATLAB |
| 7. | Obtained Time response characteristics. |
| 8. | Root locus design in MATLAB |
| 9. | Stability analysis on bode/nyquist plots in MATLAB |
| 10. | Simulation of close loop control system in Matlab Simulink. |

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech.Sem IV (Electrical Engineering)

## EL410411 Electrical workshop

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

### Laboratory Experiment List

| Sr. | Index |
|---|---|
| 1. | To study different types of wiring schemes. |
| 2. | Study of different types of fuses. |
| 3. | Study of different types of circuit breakers. |
| 4. | To study different types of wires and cables. |
| 5. | To describe and study different types of electric lamps. |
| 6. | To study and perform Staircase Wiring. |
| 7. | To study and perform Godown Wiring. |
| 8. | To perform and understand the concepts of Fuse, MCB and Earthing. |
| 9. | Study and performance of energy meter. |
| 10. | To study about illumination and performance on Lux meter. |

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech. Sem. V (Electrical Engineering)

## EL410501/EL410516 Power Electronics & Devices

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

After completion of this course, expected outcome from the students,

- Relate basic semiconductor physics to properties of real devices, and combine circuit mathematics and characteristics of linear and non-linear devices to formulate and analyse system designs.
- Learn the basic concepts of operation of different types of converters in steady state in continuous and discontinuous modes and be able to analyze basic converter topologies.
- Apply skills in engineering estimation to analyze real-world situations, identify the important features and develop a valid approach to the solution.
- Power electronics is the application of solid-state electronics for the control and conversion of electric power.
- It also refers to a subject of research in electronic and electrical engineering which deals with design, control, computation and integration of nonlinear, time varying energy processing electronic systems with fast dynamics.

## Subject Contents

**Unit-1** **[11]**

**Introduction of Power Semiconductor Devices:**
Power Electronics System(PES), Ideal and practical switch characteristics, Switch specifications, Semiconductor materials for Power Switches, Power Switch Classification, Constructional & Characteristics of SCRS, GTO, DIACs, TRIACs, UJTS, MOSFET and IGBT.

**Unit-2** **[11]**

**AC to DC Converters:**

Operation and analysis of Single phase and multi-phase uncontrolled and controlled rectifiers with R, RL and back EMF load, effect of source inductance, freewheeling effect, power factor improvement methods for phase controlled rectifiers, filters.

**Unit-3** **[11]**

**Dc To Ac Converters: Inverters:**
Classification: Voltage source inverters, Current source inverters, Single phase inverters: series, parallel and bridge type(Half wave and Full wave) inverters, Three phase bridge inverters: 180 degree conduction 120 degree conduction and their comparison, Voltage control of single phase and three phase Inverters.PWM Inverters: PWM principles, PWM techniques classifications, Sinusoidal PWM, Third harmonic PWM, Selected harmonic elimination PWM,

**Unit-4** **[12]**

**Dc To Dc Converters**
Principle of step up and step down operation – single quadrant DC chopper with R, RL and RLE load –Time ratio control – Estimation of average load voltage and load current for continuous current operation – two quadrant and four quadrant DC choppers. Voltage, current and load-commutated choppers.

**AC to AC Voltage Converter:**
Operation and analysis of single phase integral cycle and phase controlled converters, Configuration of three phase controllers.

**Text Books**


1. Rashid, M.H., "Power Electronics - Circuits Devices and Applications", Prentice Hall of India, 1995.
2. Sen .P C, "Power Electronics", Tata McGraw Hill Education, Twelfth


**Reference Books:**


1. Power Electronics and its Applications by Alok Jain, 2nd edition, Penram International Pub(India) Pvt. Ltd.
2. Power Electronics Devices, Circuits and Industrial Applications, Oxford, V.R. Moorthi
3. Power Electronics Converters, Applications and design, Wiley, Mohan, Undeland, and Robbins.
4. Various Power Semiconductor Device manufacturer's Application note and data sheets.
5. Elements of Power Electronics, Philip T. Krein .Oxford Press.
6. Power Electronics, M. D. Singh &Khanchandani, TMH.


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
**INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING**
**Department of Electrical Engineering**

## B.Tech. Sem. V (Electrical Engineering)

# EL410502 Synchronous Machines

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

After completion of this course, the students are expected to

- Learn synchronous generator, its characteristics and its applications in power.
- Learn synchronous motor, its characteristics and its applications in electrical engineering.
- Learn special machines its characteristics and its applications in electrical engineering.

## Subject Contents

**Unit-1** **[12]**

**Alternators:**

Introduction, Construction, winding and winding factors, Excitation system Working principle, production of an emf, harmonics, leakage reactance, armature reaction and its compensation, Synchronous impedance, Phasor diagrams, voltage regulation, different methods to determine voltage regulation, (synchronous impedance method, mmf method, zpf method, New ASA Method, saturated synchronous reactance method), Power flow, Operating Characteristics, power factor.

**Unit-2** **[12]**

Two reactance theory for salient pole synchronous machine, power developed, transient conditions, losses and efficiency, parallel operation of two alternators, synchronizing torque, synchronizing power, effect of increase in excitation, effect of change in torque and speed, load sharing by two alternators in parallel, synchronous machine on infinite bus bars, Measurement of Xd and Xq, transient and sub transient reactance.

**Unit-3** **[13]**

**Synchronous motor :**

Construction, principle of operation, method of starting, effect of load on synchronous motor, equivalent circuit, phasor diagram, variation in excitation, different torques, power developed in synchronous motor, power flow, two reactance concept for salient pole synchronous motor, stability, maximum load angle, V-curves, O-curves, hunting, damper winding, Synchronous condenser, synchronous phase modifiers.

**Unit-4** **[08]**

**Special machines:**

Construction of Reluctance motor and working principle, Construction of Hysteresis motor and working principle, Construction of Stepper motor and working principle, Construction of Brush-less dc motor and working principle, Construction of Servo motors and working principle.

**Text books:**


1. Ashfaq Husain: Electric Machines, Dhanpat Rai Publishers
2. Nagrath & Kothari: Electrical Machines, Tata – McGraw Hill Publication
3. Chakravorti & Mukharaji: Electrical Machines, Dhanpat Rai Publishers


**Reference Books:**


1. P S Bhimbhra: Electrical Machinery, Khanna Publishers
2. M G Say: Performance and Design of A C machines, CBS Publishers


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
**INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING**
**Department of Electrical Engineering**

## B.Tech.Sem V (Electrical Engineering)

# EL410514 Microprocessor and Interfacing

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

(Note: After completion of this course, the students are expected to ….

- Getting familiar with the architecture of 8085 Fundamental Microprocessor.
- Developed the skill of programming.
- Able to interface memory and I/O ports with 8085.
- Learned how to interface different peripheral with 8085.

## Subject Contents

**Unit-1** **[11]**

Difference between Microprocessors and Microcontroller, Microprocessor systems with bus organization, Microprocessor Architecture & Operations, Pin Functions, De-multiplexing of Buses, Generation of Control Signals, Instruction Cycle, Machine Cycles, T-States,

**Unit-2** **[11]**

Memory and I/O Interfacing, classification of Instructions, Addressing Modes, 8085 Instruction Set, Instruction and Data Formats, Programming based on data transfer, arithmetic and logical Operation, Decision Making, Looping, Developing

**Unit-3** **[12]**

Counters and Time Delay Routines, Stack & Subroutines, Restart, Conditional call and Return Instructions, Advanced Subroutine Concepts. Code Conversion, BCD Arithmetic and 16-Bit Data Operations.8085 Interrupt, Vectored and Non-Vectored Interrupts

**Unit-4** **[11]**

Interfacing Concepts, Ports, Interfacing of I/O Devices, Interfacing of Data Converters (D-To-A and A-To-D), 8255A PPI, 8253/8254 Timer, Serial I/O Concepts, SID and SOD, 8259 Programmable Interrupt Controller, Interfacing of above chips with 8085, Programming them.

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
**INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING**
## Department of Electrical Engineering

### B.Tech. Sem. V (Electrical Engineering)

# EL410504 Electrical Power Utilization

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome :**

(Note: After completion of this course, the students are expected to ….

- Maintain/Troubleshoot various lamps and fittings in use.
- Describe various electric heating and welding equipment used in industries.
- Explain the Electric Drive and elevator used in industries.
- Develop the concept of Electric Traction system.
- Study & develop various domestic electrical appliances.

## Subject Contents

**Unit-1** **[12]**

**Industrial Drives:**

Factors, selection of electric drive, types, nature of load, review of electrical characteristic, Mechanical consideration, service, capacity, rating, cost. Load equalization, selection of drive for different application.

**Electric Heating and Welding:**

Electric heating-classification, methods, resistance heating, arc-furnaces, induction heating, eddy-current heating and dielectric heating, Electric welding-resistance welding and its types, electric arc welding, welding equipment, power supply in arc welding, circuits in resistance welding-comparison.

**Unit-2** **[12]**

**Illumination:**

Terms-laws of illumination, polar curves, photometry, measurement of illumination, sources of light like arc lamps, incandescent lamp, gaseous-lamps(sodium, mercury, fluorescent, CFL), basic principles of light control, basic design of lighting scheme, lighting calculation, examples, street lighting, flood lighting.

**Electrolytic Process:**

Basic principles, faraday's laws, calculations for I, V, $\eta$. Metal deposition, extraction-refining of metal, electro-deposition, electro-platting, electro-forming etc. power supply.

**Unit-3** **[11]**

**Electric Traction:**

Electric traction, advantages, system of electric traction, speed-time curve, main, urban, sub-urban, simplified speed-time curve, mechanics of train movement, tractive effort for propulsion, energy output, SEC and factors, examples. Review of general features of traction motor, starting-speed control-braking methods for traction, sub-station, transmission line-special devices like booster transformer and negative booster. Auxiliaries.

**Unit-4** **[10]**

**Refrigeration and Air-Conditioning:**

Refrigeration cycle-system, types of refrigerants, domestic refrigerator, trouble-shooting, water-

cooler, air-conditioning, types-room and centrally AC. Heating of building, types of heaters, calculations of rating of electrical equipment.

**Text Books:**

(Chapter Wise / Full Text)

1. Electrical Power Utilization, O.S. Taylor, Orient Longman
2. Utilization of electrical power & electric traction, J. B. Gupta,S. K. Kataria

**Reference Books:**

1. A course in Electrical Power: Soni, Gupta and Bhatnagar, DhanpatRai& Sons
2. Modern electric traction H. Partab DhanpatRai.

**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

## INDUS UNIVERSITY
## INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

### B.Tech. Sem. V (Electrical Engineering)

## EL410505 Elements of Electrical Design

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome :**

(Note: After completion of this course, the students are expected to ….

- Study design of fundamental magnetic circuits, design of Electromagnets:, design of small Transformers and Choke coils, Design of starters, field regulators & control panels, Design consideration of Electrical Installation.
- Students will be able to design armature windings.

## Subject Contents

**Unit-1** **[10]**

**Fundamental of Magnetic Circuit:**
Basic principles of magnetic circuits – use of B-H curves in magnetic circuits – Calculations of MMF for air gap and teeth – Real and apparent flux density – Effect of saturation – flux density distribution -calculation of magnetizing current – Field Form – Introduction –carter's fringe curves – flux plotting – air gap flux distribution factor (field form factor) –actual flux distribution factor, Magnetising current calculation, Leakage Reactance calculation for various types of slots, Iron loss calculation concepts.

**Unit-2** **[12]**

**Design of Electromagnets:**
Introduction – Types of Electromagnets – Design of Magnet coils – Problems on abovetopics – Design of small Flat-faced armature type circular magnet – Design of large-faced armature type circular magnet – Design of Horse shoe type magnet – Design of plunger type magnet – Design of magnetic clutches
**Design of starters, field regulators & control panels:**
A.C. and D.C. starters, field regulator and general purpose control panels

**Unit-3** **[14]**

**Design of small Transformers and Choke coils:**
Design of Small single-phase transformers – Design of welding transformers – Design of variable air gap single-phase choke coil. Design of variable air gap three-phase choke coil. Design of ballast

**Estimating Costing for Residential, Commercial &Service Connections (1- ø &3-ø):**
Tenements, Row houses , Bungalows , Flats , Multi – Storied Buildings ,Internal Wiring Estimation ( Length of wire ) Commercial Complexes like Offices , Hospitals , Hotels, Theatres . Internal Wiring Estimation (Length of wire ) , Lighting Series & Hoardings.
**Design consideration of Electrical Installation:**
Types of load, Electrical Supply Systems, Wiring systems, Load Assessment, Permissible voltage drops & Conductor size calculations, Control panel, Illumination Schemes.

**Unit-4** **[9]**

**Armature Windings:**

**DC windings:**

Simplex & Duplex windings, Lap & Wave windings, Applications, Basic terms related to armature windings, Dummy Coils, Equalizer connections, split coils.

**AC windings:**

Introduction, No. of phases, Phase spread, concentric winding, Hemitropic winding, Whole coil winding, Mush winding, Double layer windings, Integral slot lap and wave winding. Fractional slot lap & wave windings. Performance analysis of various windings.

**Reference Books**


1. Electrical Estimating & Costing by N. Alagappan & S. Ekambaram (TTTI, Madras) - (Tata mcgrawhill Ltd).
2. Electrical Estimating & Costing by Surjit Singh ( DhanpatRai& sons ).
3. Electrical Machine Design by A. K. Shawney, Dhanpatrai & sons. Pub.
4. Electrical Design, Estimating & Costing By K.B.Raina & S.K.Bhattacharya (TTTI, Chandigarh) – (Wiley Eastern Ltd. ).
5. Electrical Installation, Estimating & Costing By J.B. Gupta ( S.K.Kataria & Sons ).
6. Electrical Machine Design by R. K. Agrawal.
7. Electrical Machine Design by V. N. Mittle, TMH publications.
8. Electrical Machine Design by S. K. Sen, Oxferd Publications.
9. Electrical Machine Design by Gray A. Macgraw Hill publications.


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech. Sem V (Electrical Engineering)

### Elective -I

## EL410511 Alternate Energy System

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- To educate the students scientifically the new developments in wind and Solar energy
- To emphasize the significant influence of wind and solar energy in power system.

## Subject Contents

**Unit - 1** **[11]**

**Introduction**

Recent trends in energy consumption - World energy scenario - Energy sources and their availability -Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems-need to develop new energy technologies.

**Unit - 2** **[11]**

**Wind Energy Conversion System**

Basic principle of wind energy conversion-nature of wind-wind survey in India-Power in the wind-components of wind energy –conversion system. Performance of induction generators for WECS-classification of WECS- Analysis of different wind power generators-IG -PMSG- DFIG – SEIG.

**Unit - 3** **[12]**

**Grid Connected wind Energy Systems**

Grid Connected WECS: Grid connectors concepts - wind farm and its accessories- Systems for feeding in to the Grid –Induction Generators for Direct Grid Coupling-Asynchronous Generators

in Static Cascades - Synchronous Generators Grid related problems-Generator control-Performance improvements-Different schemes-AC voltage controllers- Harmonics and PF improvement.

**Unit - 4** **[11]**

**Solar Energy Conversion System**

Photovoltaic Energy Conversion: Solar radiation and measurement-solar cells and their characteristics-PV arrays-Electrical storage with batteries- Switching devices for solar energy conversion Grid connection Issues - Principle of operation: line commutated converters (inversion-mode) – Boost and buck-boost converters-selection of inverter, battery sizing, array sizing. PV Applications: Stand alone inverters - Charge controllers - Water pumping, audio visual equipments, street lighting -analysis of PV systems.

**Reference Books:**


1. Thomas Ackermann,"Wind Power in Power Systems",JohnWiley &Sons, Ltd, 2005.
2. Mukund R. Patel,"Wind and Solar Power Systems",CRC Press, 1999.
3. MuhammedH. Rashid, "Power Electronics Handbook", Academic Press, Second edition, 2006.
4. Rao. S. & Parulekar, "Energy Technology", Khanna publishers, Fourth edition, 2005.
5. Rai, G.D., "Non- conventional resources of energy", Khanna publishers, Fourth edition, 2010.
6. Bansal N K, Kleeman and Melissa, "Renewable energy sources and conversion Techniques", Tata McGrawhill, 1990.


**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech. Sem V (Electrical Engineering)

### Elective -I

## EL410512 HVDC Transmission System

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- This course gives idea about modern trends in HVDC Transmission and its Application
- Complete analysis of harmonics and basis of protection for HVDC Systems.

### Subject Contents

**Unit-1** **[12]**

**Dc Power Transmission Technology**

Introduction-Comparison of AC and DC transmission–Application of DC transmission – Classifications of DC transmission system - Planning for HVDC transmission–Modern trends in DC transmission–DC breakers– Cables, VSC based HVDC. Comparison of Line Commutated Converter (LCC) link and Voltage Source Converter (VSC) link.

**Unit-2** **[13]**

**Analysis of HVDC Converters**

Pulse number, choice of converter configuration–Simplified analysis of Gates circuit-Converter bridge characteristics –characteristics of a twelve pulse converter-detailed analysis of converters. General principles of DC link control –Converter control characteristics–

**Unit-3** **[10]**

**Control Techniques and MTDC System**

System control hierarchy- Firing angle control – Current and extinction angle control– Generation of harmonics and filtering -power control– Higher level controllers.

Introduction–Potential applications of MTDC systems-Types of MTDC systems-Control and protection of MTDC systems-Study of MTDC systems-parallel operation of AC and DC transmission.

**Unit-4** **[10]**

**Harmonics and Power flow analysis In Ac/Dc Systems**
Harmonics on AC and DC sides – filters, Per unit system for DC Quantities-Modeling of DC links-Solution of DC load flow -Solution of AC-DC power flow- Case studies.

**Reference Books:**


1. K.R.Padiyar, "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.
2. V. Kamaraju, "HVDC Transmission", Tata McGraw Hill Publication.
3. J.Arrillaga, ,"High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
4. P.Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
5. Erich Uhlmann, "Power Transmission by Direct Current", BS Publications, 2004.
6. V.K.Sood, "HVDC and FACTS controllers – Applications of Static Converters in Power System", Kluwer Academic Publishers, April 2004.
7. Jos Arrillaga, Liu Y.H. and Neville R.Watson, "Flexible Power Transmission: The HVDC Options",Wiley Publishers, 2007.
8. Edward Wilson Kimbark,, "Direct Current Transmission", Vol -1, John Wiley & Sons Publication, 1971


**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
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## Department of Electrical Engineering

## B.Tech. Sem V (Electrical Engineering)

### Elective -I

## EL410513 Signals and System

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Understanding the analysis of continuous time signal & systems.
- Learn the sampling theorem & z-transform method.
- Learn the discrete time system with finite & infinite duration impulse response.

### Subject Contents

**Unit-1** **[10]**

**Signals and Systems**:

Continuous-Time and Discrete-Time Signals. Transformations of the Independent Variable. Exponential and Sinusoidal Signals. The Unit Impulse and Unit Step Functions. Continuous-Time and Discrete-Time Systems. Basic System Properties.

**Unit-2** **[12]**

**Linear Time-Invariant Systems:**

Discrete-Time LTI Systems: The Convolution Sum. Continuous-Time LTI Systems: The Convolution Integral. Properties of Linear Time-Invariant Systems.

**Sampling:**

Representation of a Continuous-Time Signal by Its Samples: The Sampling Theorem. Reconstruction of a Signal from Its Samples Using Interpolation. The Effect of under sampling: Aliasing. Discrete-Time Processing of Continuous-Time Signals. Sampling of Discrete-Time Signals.

**Unit-3** **[11]**

**The Laplace Transform:**

The Laplace Transform. The Region of Convergence for Laplace Transforms. The Inverse Laplace Transform. Properties of the Laplace Transform. Some Laplace Transform Pairs.

**The Z-Transform:**

The z-Transform. The Region of Convergence for the z-Transform. The Inverse z-Transform. Properties of the z-Transform. Some Common z-Transform Pairs. Analysis and Characterization of LTI Systems Using z-Transforms. System Function Algebra and Block Diagram Representations. The Unilateral z-Transforms.

**Unit-4** **[12]**

**Fourier series Representation of Periodic Signals**:

The Response of LTI Systems to Complex Exponentials. Fourier series Representation of Continuous-Time Periodic Signals. Properties of Continuous-Time Fourier series. Fourier series Representation of Discrete-Time Periodic Signals. Properties of Discrete-Time Fourier series, Fourier series and LTI Systems.

**The Continuous-Time Fourier Transform:**

Representation of a periodic Signal: The Continuous-Time Fourier Transform. The Fourier Transform for Periodic Signals. Properties of the Continuous-Time Fourier Transform. The Convolution Property. The Multiplication Property. Tables of Fourier Properties and Basic Fourier Transform Pairs.

**Text Book:**

1. AlanV.Oppenheim, Alan S.Willsky with S.Hamid Nawab, Signals & Systems, 2nd edn., Pearson Education, 1997.

**Reference Books:**

1. John G.Proakis and Dimitris G.Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 3rd edn., PHI, 2000.
2. M.J.Roberts, Signals and Systems Analysis using Transform method and MATLAB, TMH 2003.
3. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley, 1999

**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
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# EL410507 Power Electronics & Devices Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| **Class Room Contact Hrs** | **Practical** | **Activity Based Learning** | **Credits** | **University Examination** | **Mid Sem Examination** | **Continuous Evaluation** | **Total Marks** |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr.No. | List of Experiments |
|---|---|
| 1. | R-RC Triggering |
| 2 | Characteristics Of SCR |
| 3 | Characteristics Of MOSFET |
| 4 | Characteristics Of IGBT |
| 5 | UJT And Pedestal Triggering |
| 6 | Four Modes Of TRIAC And DIAC Characteristics |
| 7 | Phase Control of TRIAC |
| 8 | Half Wave controlled Rectifier |
| 9 | Full Controlled Rectifier |
| 10 | Parallel Inverter |

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# EL410508 Synchronous Machines Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | List of Experiments |
|---|---|
| 1. | Three phase Synchronous machine components |
| 2. | To study the variation of terminal voltage of Alternator on load |
| 3. | OC test on three phase Alternator |
| 4. | SC test on three phase Alternator |
| 5. | Determination of parameters of Synchronous machine |
| 6. | V curves of a three - phase Synchronous motor |
| 7. | Improvement of power factor using synchronous motor |
| 8. | Measurement of insulation of three phase Synchronous machine |
| 9. | To study the construction and working principle of Reluctance motor |
| 10. | To study the construction and working principle of Hysteresis motor |
| 11. | To study the construction and working principle of Stepper motor |
| 12. | To study the construction and working principle of Servo motors |

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**B.Tech Sem V (Electrical Engineering)**

# EL410515 Microprocessor and Interfacing Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr.No | List of Experiments |
|---|---|
| 1 | Study Trainer Kit of 8085 Microprocessor. |
| 2 | To perform data transfer operation of 8085 Microprocessor |
| 3 | To perform arithmetic and logical operation of 8085 Microprocessor. |
| 4 | Observing T-States, Machine cycles and instruction cycle on oscilloscope. |
| 5 | Simulate the program based on timer/counter using 8085 Microprocessor. |
| 6 | Design digital clock using 8085 Microprocessor. |
| 7 | To perform code conversion of 8085 Microprocessor. |
| 8 | Simulate the program based on Interrupt using 8085 microprocessor. |
| 9 | Interface 8255 with 8085 Microprocessor and control Traffic signals. |
| 10 | Interface 8253/8254 with 8085 Microprocessor. |
| 11 | Interface ADC with 8085 Microprocessor. |
| 12 | Interface DAC with 8085 Microprocessor. |

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**B.Tech Sem V (Electrical Engineering)**

# EL410510 Elements of Electrical Design Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr.No. | List of Sheets |
|---|---|
| 1 | Design of simplex Lap Winding. |
| 2 | Design of simplex Wave Winding. |
| 3 | Design of Electromagnets. |
| 4 | Design of Starters. |
| 5 | Rural Electrification |

# EL410506 Mini Projects

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 60 | 00 | 2 | 60 | -- | 40 | 100 |

## Targeted Objectives:

Students are required design, develop, simulate, Fabricate & operate Hardware Circuits with supported software during Mini Project Sessions.

The Projects must be relevant to their core engineering field and should have sufficient practical significance.

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## B. Tech. Sem. VI (Electrical Engineering)

# EL410601/EL410617 High Voltage Engineering

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| **Class Room Contact Hrs** | **Practical** | **Activity Based Learning** | **Credits** | **University Examination** | **Mid Sem Examination** | **Continuous Evaluation** | **Total Marks** |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**
(Note: After completion of this course, the students are expected to ….

- Learn breakdown conduction in Liquid, Solid and Gases.
- Learn Measurement and Generation of High Voltage & Current.
- Testing of Materials and Electrical Apparatus.
- Also Learn Design of High Voltage Lab Layout

## Subject Contents

**Unit -1**

**Conduction And Breakdown In Gases, solid dielectrics and liquids [12]**

Gases as insulating media- Ionization process-Townsend's current growth equation-Townsend's criterion-determination of $\alpha,\gamma$-time lag-streamer theory-Pachen's law-corona discharge-breakdown in non-uniform field –post breakdown phenomenon-vacuum breakdown

Conduction and breakdown in pure liquid and commercial liquid-suspended particle-bubble &cavitations-stress oil volume mechanism-breakdown mechanism in solid like intrinsic breakdown, electromechanical breakdown-treeing & tracking ,thermal , electrochemical & internal discharge breakdown. Breakdown in composite dielectric

**Unit -2**

**Generation of High Voltage AC, DC and Impulse [11]**

Generation of High voltage DC-Half & full wave rectifier, voltage doubler and multiplier circuit, Van De graff generator, Generation of High Voltage AC- Cascade transformer, Resonant transformer, High voltage-high frequency generation, Generation of Impulse Voltages-Generation of standard impulse voltages, multi stage impulse generator-Marx Circuit, Generation of Switching Surges

**Unit-3** **[11]**

**Measurement of High Voltage and Current:**

HVDC measurement by series resistance μ-meter, potential divider, generating voltmeter etc., Ripple voltage measurement, HVAC and impulse by series impedance, capacitance potential divider and CVT-PT–electrostatic voltmeter-peak voltmeter, spark gap measurement, factors &its corrections, impulse measurement by potential divider & CRO, CVT. Ohmic shunt for high DC current, hall generator, optical sensors.

**Unit -4** **[11]**

**Testing of Material And Electrical Apparatus:**

Measurement of DC resistivity-measuring cell for solid and liquid, measurement of C & tan δ, High voltage shearing bridge, transformer ratio arm bridges, partial discharge measurement-pattern straight detector, balanced detection method, HV testing of insulator, bushing, circuit breaker, cable, transformers, LA. R.I. measurement.

**Design Planning And Layout Of High Voltage Lab:**

Classification, test facilities, test equipments, layout, grounding and shielding

**Text Books**


1. C.L.Wadhawa, High voltage Engineering New Age Publishers.
2. Kuffel & Zaengl, High voltage Engineering fundamentals, Pergoman press oxford


**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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**Department of Electrical Engineering**

## B.Tech. Sem. VI (Electrical Engineering)

# EL410602/EL410618 Electrical Drives & Control

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**
After completion of this course, expected outcome from the students,

- Adjustable speed drive (ASD) or variable-speed drive (VSD) describes equipment used to control the speed of machinery.
- Understand the concepts of DC drive, AC drive and their control.
- Many industrial processes such as assembly lines must operate at different speeds for different products. Where process conditions demand adjustment of flow from a pump or fan, varying the speed of the drive may save energy compared with other techniques for flow control.

## Subject Contents

**Unit-1** **[13]**

**Introduction to Electric Drive, its Dynamics & Control**

Introduction-Block Diagram, Advantages, Parts Of Electrical Drive, Choice of Electric drive, Dynamics of electric drive: fundamental torque equation, multi quadrant operation of drive, equivalent values of drive parameter, components of load torque, nature & classification of load torque, time and energy loss in transient operation, steady state stability, load equalization, Control: modes of operation, closed loop control of drive, thermal model for heating & cooling.

**Unit-2** **[12]**

**DC motor Drive:**

DC motor-Types and their performance, armature back emf, torque, speed equations, starting, braking methods, Speed control classification, Controlled rectifier fed dc drives, Single phase fully controlled & half controlled Rectifier Control of dc Separately Excited motor, three phase fully controlled rectifier control of dc separately excited motor, multi quadrant operation of separately excited dc motor, Chopper control of separately excited dc motor drive, closed loop control of dc drive.

**Unit-3** **[12]**

**Induction Motor drive**

Introduction, Analysis and performance of 3-phase induction motor, Operation of I.M with unbalanced source voltages and single-phasing, with unbalanced rotor impedance, Analysis of I.M fed from non-sinusoidal voltage supply. Braking methods, Types of speed control, pole changing, Stator voltage control, variable frequency control, (V/F control), VVVF Control, slip speed control, VSI Controlled I.M drive, CSI control of drive, Comparison of CSI & VSI, Rotor Resistance control, slip power recovery scheme, Static Scherbius drive, Static Kramer drive.

**Unit-4** **[8]**

**Advanced Control Techniques**

Vector Control of 3-ph Induction motor, Direct & Indirect Control, Direct Torque Control (DTC), space vector control.

**Textbooks :**

1. Electric drives: concepts and applications by Vedam Subrahmanyam ( McGraw Hill)
2. Fundamentals of Electric drive - 2nd edition by G. K. Dubey (Narosa Publication)

**Reference Books:**

1. Electric Motor Drives, Modelling, Analysis and Control by R. Krishnan (PHI Learning Pvt Ltd)
2. Thyristor DC Drives by P C Sen (john wiley)
3. Modern Power Electronics and AC drives by Bimal K Bose (PHI Learning Pvt Ltd)
4. Electric Drives by Ion Boldea & SayedNasar (Tayelor & Francis)
5. Electric Drives by N.K DE & P. K Sen, (PHI Learning Pvt Ltd.)
6. Theodore Wildi, "Electronical machines, drives and power systems", Sixth edition, Pearson Education.
7. Fundamentals of Electric Drives and Control by B.R Gupta & V. Singhal, (S.K Kataria & Sons Publisher).

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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## B.Tech. Sem. VI (Electrical Engineering)

# EL410615N/EL410619 Electrical Machine Design-I

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

(Note: After completion of this course, the students are expected to ….

- Study traditional methodologies for the analysis and the design of the electrical machines.
- Develop the knowledge about the calculation of total MMF in the machine and design of various electromagnets.
- Develop skills in designing various transformers and choke coils.
- Compare out power torque parameters for different size machine.
- Calculate the heat losses, core losses and mechanical losses of dc /induction/synchronous machine.

## Subject Contents

### Unit-1

**General Aspects** **[10]**

Insulating Materials & Classifications, heating of electrical machines , Cooling of Transformer and rotating machines, Electrical and Magnetic Loading , output coefficient, factor affecting size of machines, selection of B av & ac, Duty cycle and equivalent ratings.

**Design of Transformer: (Constructional Details)**

Types of transformers, position of HV and LV windings, core and yoke cross sectional area, importance of mitered joints. Different types of transformers windings. Different methods for cooling of transformer, Different positions of tapings.

## Unit-2

**Design of Transformer: (Design Details) [15]**

Output equation for 3 phase transformers, window space factor, factors affecting window space factor. Relation between emf per turn and transformer rating, factors affecting constant K, stacking factor, examples. Selection of flux density and current density, Window dimensions, Yoke dimensions and overall core dimension calculations, examples. Design of HV and LV windings (No. of turns and area of cross section). Estimation of operating characteristics. Primary and secondary winding resistance. Leakage reactance calculation of only cylindrical coil with equal height, Leakage reactance of unequal windings and heights, only formula. No load current calculations for 3 phase transformers. Temperature rise of transformer, design of tank with tubes, calculation of dimension of tank, examples. Optimum design Design for minimum cost. Design for minimum loss. Variation of output and losses in transformer with linear dimensions. Dry transformer, high frequency transformer

## Unit-3

**Design of D.C. Machines: [10]**

Introduction, output equation, mmf calculation Selection of Number of poles, core length, armature diameter, Carter's fringing curves, length of air gap, examples on above topics costing

**Armature design**

Choice of armature winding, armature conductor, number of armature slots, slot dimensions, slot loading, design of armature core, Problems on above topics, costing

## Unit-4

**Design of field systems: [10]**

Pole design, design of field winding of shunt, series and compound machines, examples, Design of interpole, effects and minimization armature reaction Design of Commutator and brushes, Improvement in commutation, Performance calculation & Design consideration for large machines, HV machines and miniature DC motors

**Design of current transformers**

Introduction, construction Design principles OF C.T & P.T., winding design, Behavior of transformer under normal and abnormal condition.

**Text Book(s)**

1. Sawhney, A.K. "A Course in Electrical Machine Design", Dhanpat Rai and Sons, New Delhi.

2. Sen, S.K., "Principles of Electrical Machine Design with Computer Programs," Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 1987.

**Reference Books**

1. Upadhyay, K.G., "Design of Electrical Machine," New Age International Publishers, New Delhi.
2. V.N.Mittle & A.Mittal."Design of Electrical Machines" Standard Publishers Distributors, Delhi-32.

**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
**INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING**
**Department of Electrical Engineering**

## B.Tech. Sem. VI (Electrical Engineering)

# EL410605 Microcontrollers & Applications

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Getting familiar with the architecture of 8051 family microcontrollers.
- Learn the assembly and embedded C language Programming of 8051.
- Learn the interfacing of microcontroller and based on that develop various Application using Microcontroller.

## Subject Contents

**Unit -1** **[11]**

**Introduction to 8051 Microcontroller**:

Introduction, Difference between Microprocessors and Microcontrollers. Overview of 8051 Microcontroller family. Overview of PIC, ARM, AVR microcontrollers.

**Architecture of 8051 Microcontroller:**

Introduction, 8051 microcontroller hardware, Pin diagram of 8051, input/output pins, ports and circuits. Internal RAM and ROM, SFR's, interfacing with external memory, timers and counters, interrupts, Serial data communication (UART).

**Unit -2** **[11]**

**8051 Assembly language Programming:**

Addressing modes, data transfer instructions, Logical instructions, Arithmetic instructions, Branching (Jump & Call) instructions, Bit addressable instructions and special instructions, Interrupts and interrupt handler sub routines (Interrupt Service Routines).

**Unit -3** **[12]**

**8051 Programming in Embedded C:**

Introduction, Date types in embedded C, arithmetic and logical operators, Control statements and loops in embedded C, Functions and Arrays in embedded C. Programming of input/ output ports, Programming of Timer & counters, writing interrupt service routines in Embedded C, Programming of UART in embedded C.

**Unit -4** **[11]**

**8051 Interfacing**:

Introduction, Interfacing and C programming of 8051 with keyboard, Interfacing and C programming of 8051 with 7-segment display, Interfacing and C programming of 8051 with LCD display, Interfacing and C programming of 8051 with ADC-DAC and sensors.

**Text Books:**

1. The 8051 Microcontroller and embedded systems using Assemble and C. by –Muhammad Ali Mazidi and Janice Gillipse Mazidi( Pearson Education).

**Reference Books:**

1. The 8051 Microcontroller Architecture, Programming & Applications by- Kenneth J. Ayala (Penram International)
2. Programming and Customizing the 8051 Microcontroller by MykePredko Tata Mcgraw Hill.
3. 8051 Microcontrollers: MCS51 family and its variants by Satish Shah, Oxford University Press.
4. The 8051 Microcontroller & Embedded systems using Assembly and C. by – K. J. Ayala, D.V. Gadre ( Cengage Learning, India Edition).

**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
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**Department of Electrical Engineering**

## B.Tech. Sem. VI (Electrical Engineering)

# EL410604 Power System Analysis

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 60 | 00 | 00 | 4 | 60 | 30 | 10 | 100 |

**Course Objective:**
After completion of this course, expected outcome from the students,

- To study short circuit symmetrical and unsymmetrical condition.
- To study power flow Analysis using different mathematical methods.

## Subject Contents

**Unit-1** **[16]**
**Load Flow Study:**
Importance, Power flow equation, bus classification, problem formulation & constraint, methods of load flow study, Gauss-Seidel method, Newton-Raphson method, Decouple method & fast decouple method, comparison, algorithms.

**Unit-2** **[14]**
**Power System Stability:**
Stability concept, steady-state stability, swing equations, multi-machines, equal area criteria, critical clearing angle and critical clearing time, transient disturbance, solution of swing equation, numerical methods, transient stability, factors affecting transient stability, improving system stability methods.

**Unit-3** **[14]**
**Symmetrical Fault Analysis:**
Per Unit System, Reactance Diagram, Fault, sources of fault power, percentage reactance, base KVA, switching operation of R-L circuit, three-phase short-circuit on three-phase alternator, Algorithms for short circuit studies. Fault limiting reactor- types, construction, methods of locating reactors.

**Unit-4** **[16]**

**Symmetrical Component:**

Properties of symmetrical components, sequence components, their relation, star-delta transformer, symmetrical component for unsymmetrical faults.

**Unsymmetrical Fault Analysis:**

Faults, types, sequence impedance & network, sequence network for synchronous machine, transmission line, transformers, various faults at unloaded generators, three-phase L-G, L-L, L-L-G, open conductor fault, bus impedance matrix method for analysis of unsymmetrical faults

**Reference Books:**


1. Power System Analysis, Prabhakundur
2. Power System Analysis & Design,B. R. Gupta,Wheeler
3. Modern Power System Analysis, I. J. Nagrath& D. P. Kothari, TMH
4. Elements Power System Analysis, W. D. Stevenson, TMH
5. A Text Book of Power System Engineering, Sony, Gupta, Bhatnagar and Chakraborty, Dhanpat Rai
6. Power System Analysis, M. A. Pai,TMH
7. Power System Analysis, Hadi Sadat, TMH


**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech. Sem VI (Electrical Engineering)
## Elective -II
## EL410611 Energy Management and Audit

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- To study the concepts behind economic analysis and load management.
- To emphasize the energy management on various electrical equipments and metering.
- To illustrate the concept of lighting systems and cogeneration.

## Subject Contents

**Unit - 1** **[11]**

**Introduction**

Need for energy management–energy basics–designing and starting an energy management program – energy accounting – energy monitoring, Targeting and reporting-energy audit Process

**Unit - 2** **[12]**

**Energy Cost and load Management**

Important concepts in an economic analysis–economic models–time value of money –utility rate structures – cost of electricity –loss evaluation. Load management: demand control techniques – utility monitoring and control system- HVAC and energy management – economic justification.

**Unit - 3** **[10]**

**Energy audit for motors, Systems and Electrical Equipments**

Systems and equipment – electric motors – transformers and reactors – capacitors and synchronous machines.

**Unit - 4** **[12]**

**Metering For Energy Management**

Relationships between parameters–Units of measure–typical cost factors– utility meters–timing of meter disc for kilowatt measurement–demand meters–paralleling of current transformers–instrument transformer burdens –Multitasking solid-state meters – metering location vs. requirements –Metering techniques and practical examples.

**Reference Books:**


1. Eastop T.D, Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific &Technical, 1990.
2. Reay D. A. "Industrial Energy Conservation", first edition, Pergamon Press, 1977.
3. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.


**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B. Tech. Sem VI (Electrical Engineering)

## Elective -II
## EL410612 Modern Control Theory

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Learn the analysis & design of nonlinear control system.
- Learn the state variable analysis and its representation.

### Subject Contents

**Unit-1** **[10]**

**State variable analysis**:

Introduction, concepts of state, state variables and state model, state-space representation for linear continuous-time systems and discrete-time systems. Time domain solution of state equations: Solution of homogeneous state equations, state transition matrix, methods for evaluation of matrix exponential ($e^{At}$), solution of non- homogeneous state equations.

**Unit-2** **[12]**

**State-space representation**: State-space representation of high-order differential equations, state space representation of transfer function in controllable, observable and diagonal form, relationship between state equations and transfer function. Signal flow graph of state equations, decomposition of transfer function, diagonalization, eigen values and eigen vectors, modal matrix.

**Controllability and observability**: Concepts, alternative tests on controllability and observability, relationship between controllability, observability and transfer function, pole placement by state feedback, design of state feedback controller.

**Unit-3** **[11]**

**Nonlinear Control Systems and Analysis**

Introduction, Definition of nonlinear systems**,** Difference between linear and nonlinear systems, Characteristics of nonlinear systems**,** limit cycle, jump resonance, Common physical nonlinearities.

**Phase Plane Analysis**: Phase plane method- basic concept, phase trajectories, phase portrait, singular points and their types/classification, Construction of phase trajectories using isocline method, delta method.

**Unit-4** **[12]**

**Describing Function (DF) Analysis:**

Derivation of general DF, DF of common non-linearities, Stability analysis of nonlinear system by DF method, Prediction and stability of limit cycle, DF of Relay(on-off), Dead-zone, Hysteresis, Saturation and Friction-controlled Backlash.

**Text Books:**


1. M. Gopal, "Modern Control System Theory", Wiley Eastern Ltd., New Delhi.
2. M. Gopal, "Digital control & state variable method", PHI
3. K.Ogata,"Modern Control Engineering",3rd.ed. Prentice Hall of India(P)Ltd., New Delhi.
4. U.A. Patel "Control System Engineering", Mahajan Publication.


**Reference Books:**


1. GeneF. Franklin, J David Powell, Abbas Emami-Naeini, Feedback Control of Dynamic systems, 5th ed Pearson Educations.
2. Shankar Sastry, Marc Bodson, "Adaptive Control", Prentice Hall of India (P) Ltd., 1993.
3. John Doyle, Bruce Francis, Allen Tannenbaum, "Feedback Control Theory"
4. Ken dutton, Steve Thompson & Bill, "The art of control engineering".


**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech. Sem VI (Electrical Engineering)
## Elective –II

## EL410613 Digital Signal Processing

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- To understand the analysis of signals in digital domain & its application
- To learn the Filter Design
- To understand the Architecture of the DSP Processor

## Subject Contents

**Unit - 1** **[14]**

**Analysis of Signals**

Fourier Series(Trigonometric and exponential, Fourier Transform Convolution concept, Sampling theorem, Analog to digital Conversion, Discrete time signals, Analysis of Discrete time systems, Z transform, inverse Z transform with properties.

**Analysis of Signals in Digital Domain**

Discrete Fourier Transform (DFT) and inverse DFT, FFT algorithm, frequency analysis of discrete time signal, power density, energy density.

**Unit - 2** **[10]**

**FIR Filter:**

Symmetric, Anti-symmetric Filter design using windows, frequency sampling techniques, brief idea about alternation theorem and equi-ripple filter, design structure-direct form and cascade form, structure realization.

**Unit -3** **[10]**

**IIR Filter:**

Basic concepts of analog filter design using Butterworth and chebyshev applications IIR filter design methods such as impulse invariance, bilinear transform, frequency warping concept, frequency transformations, filter structures, A) Direct Form B) Parallel form C) Cascade form.

**Unit - 4** **[11]**

**Basics of DSP architecture:**

Introduction to programmable DSPs, multipler and multiplier accumulator, modified bus structures and memory access schemes, multi-ported memory, pipeling, VLIW architecture, on-chip peripherals, Effect of finite word length, recent trends in DSP system design, overview of Multimedia Applications Platform (OMAP), Evolution of FPGA based DSP system design

**Text Books:**

1. Digital Signal Processing–John Proakis and Manolakis (Prentice Hall of India Pvt .Ltd.)
2. Digital Signal Processing-A Computer based approach–S. K .Mitra (Tata McGraw Hill Publication)
3. Digital Signal Processors-B. Venkat Ramaniand Bhasker (Tata Mc Graw Hill Publishing Co., New Delhi)

**Reference Books:**

1. Discrete– time signal processing–A. V. Oppenheim, Schafer, Buck(Pearson Prentice Hall)
2. Signals and Systems–A. V. Oppenheim, Willisky (Prentice Hall of India Pvt .Ltd.)

**Question Paper Pattern :**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
**INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING**
**Department of Electrical Engineering**

**B.Tech. Sem. VI (Electrical Engineering)**

# EL410607 High Voltage Engineering Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

# Laboratory Experiment List

| Sr.No. | Index |
|---|---|
| **1.** | To study of High voltage Laboratory. |
| **2.** | To Determine the Dielectric Strength of Transformer Oil. |
| **3.** | Determination of Breakdown Voltage for Different Types of Insulating Materials. |
| **4.** | To Determine the Break down Characteristics of Air for Different shapes of Electrodes. |
| **5.** | To Study the components, control and operation of 300kV, 3kJ Impulse Generator & Observe the Impulse Wave form on Digital Storage Oscilloscope. |
| **6.** | Study of Horn Gap Type Lighting Arrester. |
| **7.** | Testing of Pin type Insulator. |
| **8.** | To Study the Effect of Movement of Impurities in Liquid Dielectric. |
| **9.** | Electric Field Plotting using Electrolytic Tank. |
| **10.** | To Understand Partial Discharge Measurement. |

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**Department of Electrical Engineering**

**B.Tech. Sem. VI (Electrical Engineering)**

# EL410608 Electrical Drives & Control Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | Index |
|---|---|
| 1 | To study the operation of a DC Drive. |
| 2 | To study the operation of AC Drive |
| 3 | To study V/f control of Induction motor using IPM PEC16DSMO1 module & Micro-2407 trainer kit. |
| 4 | Develop a MATLAB program, to plot torque-speed characteristics of poly phase Induction motor. |
| 5 | Develop a MATLAB program, to plot torque-speed characteristics of stator voltage controlled induction machine. |
| 6 | Develop a MATLAB program, to plot torque-speed characteristics of Variable voltage variable frequency controlled induction machine. |
| 7 | Develop a MATLAB program to plot torque-speed characteristics of single phase half controlled rectifier fed separately excited DC machine. |
| 8 | Develop a MATLAB program to plot torque-speed characteristics of single phase fully controlled rectifier fed separately excited DC machine. |
| 9 | Analyze the speed control of DC motor drive in armature voltage control mode of operation using MATLAB Simulink |
| 10 | Analyze the open loop control of stator voltage control of induction motor drive using MATLAB Simulink. |

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**B.Tech. Sem. VI (Electrical Engineering)**

# EL410614 Microcontrollers & Application Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | Index |
|---|---|
| 1 | Introduction to 8051 keil µ-vision4 Simulator and Trainer Kit. |
| 2 | Assembly Level Programming based on Arithmetic operation. |
| 3 | Assembly language programming based on data transfer and branch operation. |
| 4 | Assembly level programming based on data transfer, logical and branch operations. |
| 5 | Simulate program based on I/O operations. |
| 6 | Simulate Program based on Timer in 8051 |
| 7 | Simulate Program based on Embedded C. |
| 8 | Generate PWM using 8051 microcontroller. |
| 9 | Simulate Program based on serial communication. |
| 10 | Interface 16x2 LCD with 8051. |
| 11 | Interface DAC with 8051 |
| 12 | Interface ADC with 8051 |

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**Department of Electrical Engineering**

**B.Tech. Sem. VI (Electrical Engineering)**

# EL410616 ELECTRICAL MACHINE DESIGN-1 LAB

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | 00 | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | Title |
|---|---|
| 14. | Introduction to Electrical machine design |
| 15. | Sketches of components of D.C. machine |
| 16. | Sketches of components of Transformer |
| 17. | Designing of D.C. Machine in drawing sheet |
| 18. | Designing of Transformer in drawing sheet |
| 19. | Designing of Current Transformer in drawing sheet |

# INDUS UNIVERSITY
# INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech. Sem. VII (Electrical Engineering)

# EL410701Switchgear & Protection

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Objective:**

Aftercompletion of this course, expected outcome from the students,

- Students will know the operation, working applications of various switchgears and protective elements.
- Develop in students an ability and skill to design the feasible protection systems needed for each main part of a power system
- Students are knowledgeable in the field of various protection systems.

## Subject Contents

**Unit-1** **[15]**

**Switchgear:**

Elementary principles of arc interruption, Recovery, Restriking Voltage and Recovery voltages, Restriking Phenomenon. RRRV, Current Chopping and Resistance Switching, Circuit Breaker ratings and Specifications, Fusematerial, HRC fuse, liquid fuse, Application of fuse., Description and Operation of following types of circuit breakers: Air Break Circuit Breaker, Air Blast Circuit breakers, Interruption methods, Bulk oil circuit breaker, single and multi-break construction, Minimum oil circuit breaker, Voltage distribution in oil circuit breakers with arc control devices, SF6 circuit breaker, Vacuum circuit breaker, Comparison of Circuit Breakers for Application.

**Unit-2** **[15]**

**Protective Relays:**

Fault statistic, basic protection scheme, zones of protection, basic terminology. Basic requirements**,** types of protection schemes, Relay Classification, Construction & Operations of Electromagnetic, Static and Microprocessor based Relays.

**Transmission Line Protection:**

Basic line protections, methods of discrimination, rules for relay settings, problems in overcurrent relays, directional overcurrent and earth fault protection schemes, problems in directional protection, distance protection, problems in distance measurement, pilot wire protection scheme, carrier current protections.

**Unit-3** **[15]**

**Apparatus Protection Scheme:**

Protection of transformers, Percentage Differential Protection, Numerical Problem on Design of CT s Ratio, Buchholtz relay Protection. Protection of generators against Stator faults, Rotor faults, and Abnormal Conditions. Restricted Earth fault and Inter-turn fault Protection.
Bus-zone protection-requirements, non-unit protection, unit protections-frame earth protection, various differential protections, breaker back up protection
Induction

**Unit-4** **[15]**

**Neutral Grounding:**

Grounded and Ungrounded Neutral Systems, Effects of Ungrounded Neutral on system performance. Methods of Neutral Grounding: Solid, Resistance, Reactance, - Arcing Grounds and Grounding Practices.

**Relay Testing Methods andEquipments**

Installation and commissioning tests, special tests, overshoot tests, accuracy tests, range tests and stability tests, test procedure, current injection set, programmable testing equipments, digital based relay testing schemes.

**Textbooks:**


1. Power System Protection, Datte, Oza, Nair , TMH
2. Protective Relays – Theory & Practice Vol I, II, A R Van C Warington, Chapman & Hall
3. Power System Protection and Switchgear , Badri Ram &Vishvakarma, TMH


**Reference Books:**


1. JNP switchgear Handbook, R.T. Lythall,Newnes Butterworth
2. Switchgear and protection, J.B. Gupta, S. K. Kataria
3. Digital Protection, L. P. Singh, Willey Eastern


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

# INDUS UNIVERSITY

## INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
## Department of Electrical Engineering

## B.Tech. Sem VII (Electrical Engineering)

# EL410702Industrial Automation

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**

Aftercompletion of this course, expected outcome from the students,

- Learn the Automation using PID, DCS, and SCADA.
- PLC hardware and software to do automation in Industries**.**

## Subject Contents

**Unit-1** **[10]**

**General Concepts:**

General concepts of the industrial production, Concepts of production systems and production processes .Automation production systems and their classification.

**Process Control Loop and its Characteristic:**

Controlled variable, controlling parameters, process equation load, transient, process, lag, self-regulation, control lag, variable range, dead time, cycling.

**Unit-2** **[10]**

**Control Algorithms:**

Characteristic of different discontinuous controller mode, two position mode, multi position mode, floating control mode, introduction of different continuous controller mode, proportional, integral, derivative, PI, PID controller mode.

**Unit-3** **[15]**

**Programmable Logic Controller (PLC):**

Architecture by block diagram, i/o modules & programming criteria-discrete state process control, analog controller, digital controller, and intelligent controller, serial communication port. Memory and storage, programming language- ladder diagram and its application.

**Unit-4** **[10]**

**Distributed Control System:**

Evaluation of DCS, system architecture-hierarchical of DCS at function levels, Database organization, system implementation concepts System elements- fields, station, intermediate station, central computer system, Monitoring and communication facilities, data communication linktransfer of process data, SCADA.

**Text Books:**


1. Johnson, C. D., "Process Control Instrumentation Technology", Prentice Hall.
2. Liptak, B. G., "Instrument Engineers – Handbook", (Vol. – II), CRC Press.
3. Morriss, S. B., "Programmable Logic Controllers", Prentice hall.


**Reference Books:**


1. Webb, J. W., and Reis, R. A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall, (2002).
2. Shinskey, F. G., "Process Control Systems: Application, Design and Tuning", McGraw-Hill Professional, (1996).
3. Thomas E. Marlin, "Process Control: Designing Processes and Control for Dynamic Performance", McGraw – Hill, International Edition
4. Dale E. Seborg, Thomas F. Edger, Duncan A. Mellichamp, "Process Dynamics and Control", Wiley India.
5. SurekhaBhanot, "Process Control: Principles and Applications", Oxford University Press.
6. Peter Harriot, " Pocess Control", Tata - McGraw Hill.
   Patranabis, "Principles of Process Control", Tata - McGraw Hill.


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
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## B.Tech. Sem VII (Electrical Engineering)

# EL410703 Power System Design

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Outcome:**
(Note: After completion of this course, the students are expected to ….

- Study traditional methodologies for the analysis and the design of the electrical power system.
- Develop the knowledge about the calculation of electrical and mechanical design of transmission line.
- Develop skills in designing of distribution system, designing of sub-station.
- Develop designing approach in power system improvement & planning for the field of power system design.

## Subject Contents

**Unit-1** **[13]**

**Transmission Line Design:**
Electrical design of transmission line, Design philosophy, voltage level selection and choice of conductors, spacing of conductor and corona, insulators and SIL, design problem. Mechanical design of transmission line Considerations, loading on conductors, span, sag and tension clearance, stringing, problems. Transmission line tower design, Location of tower, Earth wires, Reduction of tower footing resistance, examples, EHV Transmission Line DesignConsiderations, selection, spacing of conductors, corona and radio interference, shunt and series compensation, tuned power lines, insulation coordination and different types of EHV towers, EHV systems in India.

**Unit-2** **[12]**

**Design of Distribution System:**
Types of distribution systems, arrangements, selection and size of feeders using Kelvin's law, design of cables in distribution systems considering ampere capacity, voltage drop during starting and running load, primary distribution design, secondary distribution design, Distribution substation, Calculation of distributor size and its examples, calculation of voltage drops and size of distributor,

Voltage regulation and lamp flicker, Design of rural distribution, Planning and design of town electrification scheme, Design of industrial distribution system. Economics Of Distribution System**:**Comparison of overhead-transmission and distribution system, Effect of voltage, Selection of equipment, Economic size of power apparatus, Economic selection of distribution system, Power transmission and distribution cost, Energy losses in distribution system.

**Unit-3** **[10]**

**Design of HVDC Transmission Lines:**
Introduction, Limitations of high voltage a.c. transmission, Advantaged and limitations of HVDC transmission, Principle of control of HVDC transmission, Applications of HVDC system.

**Design of Substation:**
Substation layout, selection of sizes and locations of sub stations, Substation equipments specifications ratings and its operation from design view point, selection of size and location of generating stations, Interconnection.

**Unit-4** **[10]**
**Power System Earthing:**
Objectives, Definitions, Tolerable limits of body currents, Soil resistivity, Earth resistance, Tolerable step and touch voltage , Actual Touch and step voltages, Design ofearthing grid, Tower footing resistance, Measurement of soil resistivity and earth resistance, Impulse behavior of earthing Systems, Neutral earthing.

**Text Book(s)**

1. Electrical Power System Design :M. V. Deshpande, TMH publication
2. Electrical Power System Design :B. R. Gupta, S. CHAND

**Reference Books**

1. A course in Electrical Power: Soni,Gupta and Bhatnagar, DhanpatRai& Sons
2. Substation Design: Satnam& Gupta, DhanpatRai and Co.
3. Electrical Power System Planning A. S. Pabla, TMH publication

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

**INDUS UNIVERSITY**
**INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING**
**Department of Electrical Engineering**

## B.Tech. Sem. VII (Electrical Engineering)

# EL410704 Power System Operation & Control

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Objective:**

Aftercompletion of this course, expected outcome from the students,

- Learn the Economic Operation of power system.
- Learn Load Voltage and frequency control.
- Learn power system security and optimal power flow.

## Subject Contents

**Unit-1** **[11]**

**Unit Commitment & Economic load dispatch**

Introduction and comparison of economic dispatch and unit commitment, constraints, spinning reserves, thermal unit constraints, different solution methods, priority list, dynamic programming, langrage solution methods, Transmission loss formula, penalty factor, current distribution factors

**Unit-2** **[11]**

**Load Frequency Control:**

Introduction, single area control of frequency, modeling of turbine governor, turbine generator, steady-state analysis, Generation Control – supplementary control, tie line control, generation allocation, AGC, principle of frequency control, flat frequency, selective frequency, tie-line control methods.

**Unit-3** **[13]**

**Voltage & Reactive Power Control:**

Importance of voltage control, methods: shunt reactor, shunt and series capacitors, synchronous phase modifiers, tap changing transformers, booster transformers, induction regulators. Generation and absorption of reactive power, reactive power compensation, active shunt compensation, static compensator, concept of flexible AC transmission system.

Excitation system: self & separately excitation system, DC excitation system, AC excitation system,

static excitation system, brush-less excitation system.

**Unit-4** **[10]**

**Power System Security:**

Introduction, factors affecting power system security, contingency analysis, linear sensitivity factors, ac power flow methods.

**Reference Books:**


1. Power generation, operation and Control,Wood and Wollenbarg, John Willey.
2. Power Station Engineering, I. J. Nagrath& D. P. Kothari, TMH.
3. A Course in Electricla Power, Sony, Gupta, Bhat, Chakra, DhanpatRai.
4. Electrical Power System, C. L. Wadhva, New Age.
5. Elements of Electrical power Station Design, M. V. Deshpande, Willy.


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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**Department of Electrical Engineering**

## B.Tech. Sem. VII (Electrical Engineering)

# EL410705 Electrical Machine Design II

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 00 | 3 | 60 | 30 | 10 | 100 |

**Course Objective:**
After completion of this course, expected outcome from the students,

- Learn the Economic Operation of power system.
- Learn Load Voltage and frequency control.
- Learn power system security and optimal power flow.

## Subject Contents

**Unit-1** **[11]**

**Induction motor design:**

Output equation, choice of specific scheme, separation of D & L, peripheral Stator winding design, Calculation of no. of turns per phase, conductor's area shape of the stator slots, factors to be considered while deciding no of stator slots, Area of stator slots, stator winding resistance, stator teeth design, depth of the stator core, examples related to above topics, Length of the air gap. Rotor design A. Squirrel cage rotor – selection of no. of rotor slots, harmonic induction torque. Harmonic synchronous torque, vibration and noise, voltage ripples, rules for selecting no. of rotor slots, Methods for reducing harmonic torque, design of rotor bars and slots, calculation of rotor bar current, area of rotor bars, shape of rotor slots, examples, Design of end rings, Calculation of end rings current, cross-sectional area of end rings.

**Unit-2** **[11]**

**Design of wound rotor:**

Calculation of number of rotor slots, no. of turns, cross sectional area of rotor conductors, types of rotor windings, check for rotor tooth density, design of rotor core, examples Estimation of operating characteristics- no load current calculation, short circuit current calculation, stator and rotor resistance and reactance calculation, examples, circle diagram, Dispersion coefficient – effect on maximum output power factor

Performance calculation, Design aspects for large size machine, high voltage m/c, High speed m/c, algorithm and flow chart Design of submersible motors

**Unit-3** **[13]**

**Design of single phase induction motor:**

Types of motors, Design of main dimensions, design of stator, Design of rotor, calculation of operating characteristic (rotor resistance, stator resistance, iron loss, friction and windage loss etc, Design of auxiliary winding, starting torque, circle diagram, design of capacitance for maximum torque

**Unit-4** **[10]**

**Synchronous machine design:**

Introduction, output equations, Main dimension, SCR, effect of SCR on machine performance Length of air gap and shape of pole face Armature design, Armature winding (Single layer and double layer), number of armature slots, slots dimension, length of mean turns, calculation of armature resistance and reactance Design of rotor , Design of magnetic circuit, Open circuit characteristic Determination of full load field MMF, Design of field winding Determination of direct and Quadrature axis synchronous reactance Short circuit characteristics, Performance evaluation Design of Turbo alternators, Main dimension, Length of air gap, Stator & Rotor design Algorithms and Flow chart Design consideration for low speed alternators and vertically operated alternator

**Reference Books:**


1. A Course in electrical machine design – A. K. Sawhey, DhanpatRai and Sons
2. Electrical machine design – R. K. Agrawal, S.K. Kataria& Sons
3. Design of Electrical machines – V. N. Mittle, Standard Publishers Distributors


**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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# Elective –III
# EL401711 Commissioning and Installation of Electrical Equipments

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**

- Learn the Transformer &Induction Motor Testing.
- Learn Sub Station Equipments& Commissioning of Transmission Line& Cable.

## Subject Contents

**Unit-1** **[12]**

**Transformer:**
Testing procedure for HV testing, Phase shifting / phase group, Radio interference, Ratio Test, Load loss ,Separate source voltage testing, Induced voltage testing, Impulse & Surge testing, Noise level & vibration testing, Short circuit withstand test, Tan Delta test, Core insulation voltage test, Measurement of impedance ,Testing of auxiliaries & safety device, Oil testing, Classification of testing methods, Testing of bushing. DC & AC Resistance measurement, Temp. rise test, Short circuit test, Dielectric test, Partial discharge, Insulation resistance testing. Polarity testing, Short time current rating, Impulse & surge testing, Determination of error & accuracy class, Power frequency voltage withstand test, Over voltage inter-turn test. Determination of polarization index for transformer. Drying out procedure for transformer. Commissioning steps for transformer Purification & Filtration Procedure for Transformer oil. Troubleshooting & Maintenance of transformer, conditioning monitoring.

**Unit-2** **[10]**

**Induction Motor:**
Testing (3-phase & 1-phase) - Hammer test, Testing against variation of voltage/current/frequency, Load test, NL & BR test, DC & AC Resistance measurement, Insulation measurement, Starting test, Temp. rise test, Slip measurement, HV test ,Testing on

auxiliaries, Vibration Test, Noise level test. Drying out methods / Polarization Index / Hot Temperature measurement, degree of protection (IP Grade). Commissioning steps for Induction motor, Heat Run Test. Commissioning of Induction Generator. Troubleshooting &maintenance of induction motor, condition monitoring.

**Unit -3** **[12]**

**Sub Station Equipments:**

Bus bar-Temp. Rise test, Rated short time current test, HV test, Power frequency voltage withstand test, Impulse / surge testing, Vibration & earthquake Test. Earthing resistance measurement, Substation grid Earthing, Soil resistivity measurement. Isolator Testing-Temp. Resistance test, Short circuit test, Charging current making & breaking test, Inductive current making & breaking test.Circuit breaker-Testing of HV/LV circuit breaker-No load Mechanical Operation, Mechanical endurance test, Temp. rise test ,Impulse & surge testing , short time current test. Short circuit making & breaking test, Line Charging current making & breaking test, Cable charging & capacitor bank making & breaking test, Out of phase switching, Short line fault test, and Electrical & Mechanical endurance test for LT switch gear like MCB / MCCB / ELCB etc. C.T. & P.T. Testing, Relay testing, Coupling capacitors, Station Batteries for D.C. Supply, Fire Shifting Equipments. Testing & Commissioning of Lightning Arrestor, Substation Commissioning by Thermography. Troubleshooting & maintenance of circuit breakers.

**Unit – 4[11]**

**Commissioning Of Transmission Line& Cable:**

Deratingof cable capacity, HV test, AC & DC Resistance check, Insulation resistance, Impedance measurement, Location finding technique for fault in underground cables (Murray loop test &Warley loop test) , Testing of open circuit faults in cables . Line charging, loading & Dropping.

**Textbook** :

1. Testing, Commissioning & maintenance of electrical equipment, S. S. Rao, Khanna
2. Substation Design: Satnam& Gupta, DhanpatRai and Co.

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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## B.Tech. Sem VII (Electrical Engineering)

### Elective -III

## EL410712 Advanced Power System

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**
After completion of this course, expected outcome from the students,

- As the course first introduces to students about conventional power control methods & advanced controlled methods for reactive power compensation using FACTs controllers,
- Building algorithm for $Z_{BUS}$ and its modifications, Importance of Sparsity Matrix and its various methods, Power System Transients and Lightning,
- Power System Security Analysis, Power System Operating States, Introduction to Power System State Estimation and Application of it.

### Subject Contents

**Unit – 1** **[04]**

**Introduction:**
Background, Electrical Transmission Networks, Conventional Control Mechanisms, Flexible ac Transmission Systems (FACTS), Emerging Transmission Networks

**Unit – 2** **[10]**

**Principles of conventional reactive-power compensators**
Introduction, Reactive Power Compensation, Synchronous Condensers, Thyristor Controlled Reactor (TCR), Thyristor-Controlled Transformer (TCT),Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), Mechanically Switched Capacitor-Thyristor-Controlled Reactor (MSC-TCR),Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSC-TCR), A Comparison of Different Static VAR Compensators (SVCs), Future Direction of FACTs Controller.

**Unit – 3** **[14]**

**The Impedance Model and Network Calculations**

Building Algorithm for the Bus Impedance Matrix, Modification of $Z_{BUS}$matrix due to changes in the primitive network.

**Sparsity Techniques:**

Sparse System, Theorems of Sparse Matrix Method, Various application areas and sparsity, direct solution of sparse network equations by optimally ordered triangular factorization.

**Power System Transients:**

Introduction, Traveling waves& propagation of surges on transmission lines, Bewley Lattice Diagram, lightning phenomena, Protection of transmission lines against lightning, Protection of power system apparatus against surges, Insulation coordination.

**Unit – 4** **[17]**

**Power System Security**

Introduction, System State Classification, Power System Operating States

**Introduction to State-Estimation in Power Systems**

Introduction, Power system state estimation, Maximum Likelihood Weighted Least Squares Estimation, Maximum Likely hood Concepts, Matrix Formulation, State Estimation of an AC network, State Estimation by Orthogonal Decomposition, An Introduction to Advanced topics in state estimation, Detection and Identification of Bad measurements, Estimation of quantities not being measured, Network Observability and Pseudo measurements, Application of Power Systems State Estimation

**Text Books:**


1. Thyristor-Based FACTS Controllers for Electrical Transmission Systems - R.M. Mathur / R.K. Verma, John Wiley & Sons, Inc., 2002
2. N. Hingorani, L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC transmission Systems, Delhi Publishers, ISBN-13: 9788186308790
3. Modern Power system Analysis by I J Nagrath, D P Kothari, Tata McGraw Hill.
4. Elements of Power SystemsAnalysis: W. D. Stevenson Jr., 4$^{th}$Edition, McGraw Hill International.


**Reference Books:**


1. Power System Analysis by HadiSaadat, Tata McGraw Hill.
2. Power Generation Operation & Control, John Wiley & Sons, Inc, 1996- A. J. Wood and B. F. Wollenberg

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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## B.Tech. Sem VII (Electrical Engineering)

## Elective -III
## EL410713 Embedded System

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 45 | 00 | 30 | 4 | 60 | 30 | 10 | 100 |

**Course Outcome:**
Upon completion of this course, the student will be able to:
1. Learn the programming and basic architecture of PIC18F family microcontroller and advance programming of 8051:
3. Understand and design Digital signal processor:
4.

**Subject Contents**

**Unit – 1** **[11]**

**8051 Microcontroller Advance:**
SPI communication Protocol, I2C Communication Protocol, Interfacing of 8051 with SPI and I2C based devices like ADC, DAC and RTC(Real Time Clock), Programming of timers in different modes. Programming of PCA timer in different modes, Interfacing of 8051 with DC motor and stepper motor.

**Unit – 2** **[11]**

**PIC18F Family Microcontroller:**
Architecture, oscillator configuration, power management mode, Reset Features, Memory Organization, 8x8 Hardware Multiplier.

**PIC18F4550 Family Peripheral and programming:**
Interrupt, I/O Ports, Timer Module - Capture & Compare Mode,

**Unit - 3** **[12]**

**PIC18F4550 Family Peripheral and programming:**
ADC, Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART)

**Digital Signal Processing:**
Discrete Time Signals & Systems: Introduction, Discrete time signals, discrete time systems, LTI system, Properties of LTI systems. Z-Transform: ROC, Properties of Z-transform, Inverse of ZTransform.

**Unit – 4** **[11]**

**Digital Signal Processor:**
Introduction to TMSLF2407 DSP Controller: Introduction, Brief Introduction to Peripherals, Memory and Introduction to Software tools (For Practical Work).

**Digital Signal Processor TMS320LF2407:**
General Purpose I/O Functionality: Pin multiplexing and general purpose I/O overview, Introduction to Multiplexing and general purpose I/O Control registers, General purpose I/O ports, General purpose I/O programming. Interrupts on the TMS320LF2407: Introduction to interrupts, Interrupts hierarchy, Interrupt control registers.

**Reference Books:**
1. The 8051 Microcontroller and Embedded system by Janice Gillispie Mazidi, Muhammad Ali Mazidi, and Rolin D. McKinlay
2. PIC18F Family User Guide
3. PIC18F4550 Datasheet
4. Digital Signal Processor TMS320LF2407 User Guide
5. Digital Signal Processing, Palan N. G., TechMax Publication

**Question Paper Pattern:**

Question paper will contain 8 questions (two full questions distributed in four units) covering all the chapters of the course. Student has to answer total FIVE full questions choosing at least one from each unit.

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# EL410707 Switchgear & Protection Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | List of Experiments |
|---|---|
| 1. | Study of circuit breaker and its types |
| 2. | Study of testing of relay and circuit breaker |
| 3. | To perform the working of microcontroller based over current relay |
| 4. | To perform the working of microcontroller based 3 phase differential relay |
| 5. | To perform microcontroller based directional over current relay |
| 6. | To perform microcontroller based 1 phase differential relay |
| 7. | To perform microcontroller based reverse power relay. |
| 8. | To Study of various protective equipment used in substation. |
| 9. | To study the definite time and IDMT settings of microprocessor based over current relay test kit. |
| 10. | Simulation of Generator Differential Protection |
| 11. | Simulation of Transformer Differential Protection. |

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# El410708 Industrial Automation Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | List of Experiments |
|---|---|
| 1 | To study Programmable Logic Controller (PLC), Simulation Software and different programming languages. |
| 2 | To perform and simulate ladder logic diagram of logic gates. |
| 3 | To develop a logic for traffic signal control using timer concept with PLC interfacing. |
| 4 | To develop a logic for traffic signal control using counter concept with PLC interfacing. |
| 5 | To develop a logic for interlocking operation with water level indicator. |
| 6 | To simulate a ladder logic diagram to control drilling machine operation. |
| 7 | To simulate a ladder logic diagram for operation of bottle filling and conveyer belt. |
| 8 | To verify performance of proximity sensors and optical sensors. |
| 9 | To observe SCADA (Supervisory Control And Data Acquisition) based Industrial Automation. |
| 10 | To Study about DCS (Distributed Control System)for process control plant. |

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# EL410710Electrical Machine Design-II Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| **Class Room Contact Hrs** | **Practical** | **Activity Based Learning** | **Credits** | **University Examination** | **Mid Sem Examination** | **Continuous Evaluation** | **Total Marks** |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | Index |
|---|---|
| 1. | Design of 3 phase I.M |
| 2. | Drawing sheet of 3 phase I.M with circle dia. |
| 3. | Drawing and description of syn. M/c components |
| 4. | Design of syn. m/c |
| 5. | Tutorials of single phase I.M and Submersible pumps |

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# EL410714 Power System Design Lab

| Teaching Scheme | | | | Examination Scheme | | | |
|---|---|---|---|---|---|---|---|
| Class Room Contact Hrs | Practical | Activity Based Learning | Credits | University Examination | Mid Sem Examination | Continuous Evaluation | Total Marks |
| 00 | 30 | 00 | 1 | 60 | -- | 40 | 100 |

# Laboratory Experiment List

| Sr. No. | List of Experiment |
|---|---|
| 1. | Drawing Sheet of HV / EHV Transmission Tower. |
| 2. | Drawing Sheet of LV/ MV / HV Insulators. |
| 3. | Drawing Sheet of Sub-Station. |
| 4. | Design & Drawing Sheet of Earthing Grid. |
| 5. | Design Problem of HV/EHV Transmission Line. |