

**II Year – I SEMESTER**

T	P	C
3+1	0	3

**ELECTRICAL CIRCUIT ANALYSIS-II****Preamble :**

This course aims at study of three phase systems, transient analysis, network synthesis and fourier analysis for the future study and analysis of power systems.

**Objectives:**

- i. To study the concepts of balanced three-phase circuits.
- ii. To study the concepts of unbalanced three-phase circuits.
- iii. To study the transient behaviour of electrical networks with DC, pulse and AC excitations.
- iv. To study the performance of a network based on input and output excitation/response.
- v. To understand the realization of electrical network function into electrical equivalent passive elements.
- vi. To understand the application of fourier series and fourier transforms for analysis of electrical circuits.

**UNIT-I Balanced Three phase circuits**

Phase sequence- star and delta connection - relation between line and phase voltages and currents in balanced systems - analysis of balanced three phase circuits - measurement of active and reactive power in balanced three phase systems.

**UNIT-II Unbalanced Three phase circuits**

Analysis of three phase unbalanced circuits: Loop method – Star-Delta transformation technique, Two wattmeter methods for measurement of three phase power.

**UNIT-III Transient Analysis in DC and AC circuits**

Transient response of R-L, R-C, R-L-C circuits for DC and AC excitations, Solution using differential equations and Laplace transforms.

**UNIT-IV Two Port Networks**

Two port network parameters – Z, Y, ABCD and hybrid parameters and their relations, Cascaded networks - poles and zeros of network functions.

**UNIT-V Network synthesis**

Positive real function - basic synthesis procedure - LC immittance functions - RC impedance functions and RL admittance function - RL impedance function and RC admittance function - Foster and Cauer methods.

**UNIT-VI Fourier analysis and Transforms**

Fourier theorem- Trigonometric form and exponential form of Fourier series, Conditions of symmetry- line spectra and phase angle spectra, Analysis of electrical circuits to non sinusoidal periodic waveforms.

Fourier integrals and Fourier transforms – properties of Fourier transforms and application to electrical circuits.

**Outcomes:**

- i. Students are able to solve three- phase circuits under balanced condition.
- ii. Students are able to solve three- phase circuits under unbalanced condition.
- iii. Students are able find out transient response of electrical networks with different types of excitations.
- iv. Students are able to estimate the different types of two port network parameters.
- v. Students are able to represent electrical equivalent network for a given network transfer function.
- vi. Students are able to extract different harmonics components from the response of a electrical network.

**Text Books:**

1. Engineering Circuit Analysis by William Hayt and Jack E. Kemmerley, Mc Graw Hill Company, 6th edition.
2. Network synthesis: Van Valkenburg; Prentice-Hall of India Private Ltd.

**Reference Books:**

1. Introduction to circuit analysis and design by Tildon Glisson. Jr, Springer Publications.
2. Circuits by A. Bruce Carlson, Cengage Learning Publications.
3. Network Theory Analysis and Synthesis by Smarajit Ghosh, PHI publications.
4. Networks and Systems by D. Roy Choudhury, New Age International publishers.
5. Electric Circuits by David A. Bell, Oxford publications.
6. Circuit Theory (Analysis and Synthesis) by A. Chakrabarti, Dhanpat Rai & Co.

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**THERMAL AND HYDRO PRIME MOVERS****Part-A: Thermal prime movers**

**Course Objectives:** To make the student understand the types of prime movers, which can be connected to generators for power production and should obtain the skills of performing the necessary calculations with respect to the functioning of the prime movers.

**UNIT I:**

**Objectives:** To make the student learn about the constructional features, operational details of various types of internal combustion engines through the details of several engine systems and the basic air standard cycles, that govern the engines. Further, the student shall be able to calculate the performance of different types of internal combustion engines.

**I.C Engines:** Classification, working principles – valve and port timing diagrams – air standard cycles – Engine systems line fuel injection, carburetion, ignition, cooling and lubrication – Engine performance evaluation.

**UNIT II:**

**Objectives:** To train the student in the aspects of steam formation and its utilities through the standard steam data tables and charts. To make the student correlate between the air standard cycles and the actual cycles that govern the steam turbines. To train the student to calculate the performance of steam turbines using velocity diagrams.

Properties of Steam and use of Steam Tables- T-S and H-S Diagrams. Analysis of Various Thermodynamic Processes undergone by Steam.

Vapor Power Cycles: Carnot Cycle-Rankine Cycle- Thermodynamic Variables Effecting Efficiency and output of Rankine Cycle-. Analysis of simple Rankine Cycle and Re-heat cycle.

Steam Turbines: Schematic layout of steam power plant Classification of Steam Turbines- Impulse Turbine and Reaction Turbine- Compounding in Turbines- Velocity Diagrams for simple Impulse and Reaction Turbines- Work done & efficiency.

**UNIT III:**

**Objectives:** To impart the knowledge of gas turbine fundamentals, the governing cycles and the methods to improve the efficiency of gas turbines.

**Gas Turbines:** Simple gas turbine plant-ideal cycle, closed cycle -open cycle-. Efficiency, Work ratio and optimum pressure ratio for simple gas turbine cycle. Actual cycle, analysis of simple cycles & cycles with inter cooling, reheating and Regeneration.

**Part-B: Hydro prime movers****UNIT IV:**

**Objectives:** To teach the student about the fundamental of fluid dynamic equations and its applications fluid jets. To impart the knowledge of various types of pumps, their constructional features, working and performance.

**IMPACT OF JETS AND PUMPS:** Impulse momentum equation, Impact of Jet on stationary and moving vanes (flat and curved). Pumps: Types of pumps, Centrifugal pumps: Main components, Working principle, Multi stage pumps, Performance and characteristic curves.

**UNIT V:**

**Objectives:** To make the student learn about the constructional features, operational details of various types of hydraulic turbines. Further, the student shall be able to calculate the performance of hydraulic turbines.

**HYDRAULIC TURBINES:** Classification of turbines; Working principle, Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines; Governing of turbines; Performance and characteristic curves.

**UNIT VI:**

**Objectives:** To train the student in the areas of types of hydro electric power plants, estimation and calculation of different loads by considering various factors.

**HYDRO POWER:** Components of Hydro electric power plant: pumped storage systems, Estimation of water power potential; Estimation of load on turbines: load curve, load factor, capacity factor, utilization factor, diversity factor, load – duration curve, firm power, secondary power, prediction of load.

**Text Books:**

1. Thermal Engineering by Rajput, Lakshmi publications
2. Thermal engineering by M.L.Mathur and F.S.Mehta, Jain Brothers.
3. “Hydraulics & Fluid Mechanics”, P.N. Modi and S.M. Seth, TEXT BOOKS House, Delhi
4. “Fluid Mechanics & Hydraulic Machinery” A.K.Jain, , Khanna Publishers, Delhi.

**Reference Books:**

1. “Fluid Mechanics” by Victor. L. Streeter.
2. “Introduction to Fluid Mechanics” Edward .J. Shaughnessy Jr.
3. “Fluid Mechanics & Its Applications”, Vijay Gupta, Santhosh. K.Gupta.
4. “Fluid Mechanics & Fluid power Engineering, Dr D.S. Kumar.
5. “Water Power Engineering” M.M Desumukh.

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**BASIC ELECTRONICS AND DEVICES**

**Preamble:** This course introduces the concepts of semi-conductor physics and operation of various semi-conductor devices. Realization of rectifiers, amplifiers and oscillators using semi-conductor devices and their analysis is also introduced in this course.

**Unit-I:**

**Objective:** To learn the basics of semiconductor physics.

**Review of Semi Conductor Physics:** Insulators, Semi conductors, and Metals classification using Energy Band Diagrams, Mobility and Conductivity, Electrons and holes in Intrinsic Semi conductors, Extrinsic Semi Conductor, (P and N Type semiconductor) Hall effect, Generation and Recombination of Charges, Diffusion, Continuity Equation, Injected Minority Carriers, Law of Junction, Introduction to fermi level in Intrinsic, Extrinsic semi conductors with necessary mathematics.

**Outcome:**

Students are able to understand the basic concepts of semiconductor physics, which are useful to understand the operation of diodes and transistors.

**Unit-II:****Objective:**

To study the construction details, operation and characteristics of various semiconductor diodes.

**Junction Diode Characteristics**

Operation and characteristics of p-n junction diode. Current components in p-n diode, diode equation. Temperature dependence on V-I characteristic, diffusion capacitance and diode resistance (static and dynamic), energy band diagram of p-n diode.

**Special Diodes:** Avalanche and Zener break down, Zener characteristics, tunnel diode, characteristics with the help of energy band diagrams, Varactor diode, LED, PIN diode, Photo diode.

**Outcome:**

Students are able to explain the operation and characteristics of PN junction diode and special diodes.

**Unit-III:****Objective:**

To understand the operation and analysis of rectifiers with and without filters. Further study the operation of series and shunt regulators using zener diodes.

**Rectifiers and Regulators**

Half wave rectifier, ripple factor, full wave rectifier (with and without transformer), harmonic components in a rectifier circuit, inductor filter, capacitor filter, L-section filter,  $\Pi$ - section filter, and comparison of various filter circuits in terms of ripple factors. Simple circuit of a regulator using Zener diode. Types of regulators-series and shunt voltage regulators, over load voltage protection.

**Outcome:**

Ability to understand operation and design aspects of rectifiers and regulators.

**Unit-IV:****Objective:**

To study the characteristics of different bipolar junction transistors and their biasing stabilization and compensation techniques. To analyze transistor amplifiers using h-parameters.

**Transistors**

Junction transistor, transistor current components, transistor as an amplifier and switch. Characteristics of transistor (CE, CB and CC configurations). Transistor biasing and thermal stabilization (to fixed bias, collector to base bias, self bias). Compensation against variation in base emitter voltage and collector current. Thermal runaway. Hybrid model of transistor. Analysis of transistor amplifier using h-parameters

**Outcome:**

Students are able to understand the characteristics of various transistor configurations. They become familiar with different biasing, stabilization and compensation techniques used in transistor circuits.

**Unit- V:****Objective:**

To understand the basics of FET,Thyristors, Power IGBTs and Power MOSFETs.

**Power semiconductor devices**

Principle of operation and characteristics of Thyristors, Silicon control



rectifiers, power IGBT and power MOSFET their ratings. Comparison of power devices.

**FET:** JFET Characteristics (Qualitative explanation), MOFET Characteristics–static and Transfer (enhancement and depletion mode), low frequency model of FET, FET as an amplifier.

**Outcome:**

Students are able to understand the operation and characteristics of FET, Thyristors, Power IGBTs and Power MOSFETs.

**Unit VI :**

**Objective:**

To understand the concepts of positive and negative feedbacks and their role in amplifiers and oscillators.

**Amplifiers and oscillators**

Feedback Amplifiers -classification, feedback concept, transfer gain and general characteristics of negative feedback amplifiers, effect of feedback on input and output resistances. Methods of analysis of feedback amplifiers.

Power Amplifiers – Classification, push-pull amplifiers, Introduction to harmonics (distortion factor).

Oscillators – Condition for oscillation, RC-phase shift oscillator. Wein bridge oscillator, Crystal oscillator. Frequency and amplitude stability of oscillators.

**Outcome:**

Students are able to understand the merits and demerits of positive and negative feedback and the role of feedback in oscillators and amplifiers.

**TEXT BOOKS:**

1. Electronic Devices and Circuits – J. Millman, C.C. Halkias, Tata Mc-Graw Hill.
2. Electronics devices and circuits by Atul P. Godse, Uday, Bakshi, Technical Publication.

**REFERENCE BOOKS:**

1. Electronic Devices and Circuits by David A. Bell, Oxford University Press.
2. Electronic Devices and Circuits – Salivahanan, Kumar, Vallavaraj, TATA Mc Graw Hill, Second Edition.
3. Electronic Devices and Circuits – R.L. Boylestad and Louis Nashelsky, Pearson/Prentice Hall, 9<sup>th</sup> Edition, 2006.

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**COMPLEX VARIABLE AND STATISTICAL METHODS****UNIT-I Functions of a complex variable:**

Introduction – Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in Cartesian and polar coordinates. Harmonic and conjugate harmonic functions – Milne – Thompson method.

Subject Category

ABET Learning Objectives a e

ABET internal assessments 1 2 6

JNTUK External Evaluation A B E

**UNIT-II Integration and Series Expansions**

Complex integration: Line integral – Cauchy's integral theorem, Cauchy's integral formula, Generalized integral formula (all without proofs)-

Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series.

Subject Category

ABET Learning Objectives a e k

ABET internal assessments 1 2 6

JNTUK External Evaluation A B E

**UNIT III Integration using Residues:**

Types of Singularities: Isolated, pole of order m, essential - Residues – Residue theorem( without proof) - Evaluation of real integrals of type (a)

(b) (c)

Subject Category

ABET Learning Objectives a e

ABET internal assessments 1 2 6

JNTUK External Evaluation A B E

**UNIT IV Conformal Mapping:**

Transformation by  $\exp z$ ,  $\ln z$ ,  $z^2$ ,  $z^n$  (n positive integer),  $\sin z$ ,  $\cos z$ ,  $z + a/z$  - Translation, rotation, inversion and bilinear transformation – fixed point – cross ratio – properties – invariance of circles.

Subject Category

ABET Learning Objectives a e k

ABET internal assessments 1 2 6

JNTUK External Evaluation A B E

### **UNIT V Sampling Distributions:**

Review of Normal distribution - Population and samples - Sampling distribution of mean (with known and unknown variance), proportion, variances - Sampling distribution of sums and differences - Point and interval estimators for means, variances, proportions.

Subject Category

ABET Learning Objectives a e k

ABET internal assessments 1 2 6

JNTUK External Evaluation A B E

### **UNIT VI Tests of Hypothesis**

Type I and Type II errors - Maximum error- One tail, two-tail tests - Tests concerning one mean and proportion, two means- Proportions and their differences using Z-test, Student's t-test - F-test and Chi-square test.

Subject Category

ABET Learning Objectives a b d e h k

ABET internal assessments 1 2 6 7 10

JNTUK External Evaluation A B E F D

### **Books:**

1. Advanced Engineering Mathematics: Erwin Kreyszig, Wiley India Edition.
2. Advanced Engineering Mathematics: Michael Greenberg, Pearson.
3. Advanced Engineering Mathematics: BS Grewal, Khanna Publishers (42<sup>nd</sup> Ed).
4. Probability and Statistics for Engineers: Miller and John E. Freund, Prentice Hall of India.
5. Probability and Statistics for Engineers and Scientists: Ronald E. Walpole, Sharon L. Myers and Keying Ye: Pearson.

Subject Category	ABET Learning Objectives	ABET Internal Assessments	JNTUK External Evaluation	Remarks
Theory Design Analysis Algorithms Drawing Others	a) Apply knowledge of math, science, & engineering b) Design & conduct experiments, analyze & interpret data c) Design a system/process to meet desired needs within economic, social, political, ethical, health/safety, manufacturability, & sustainability constraints d) Function on multidisciplinary teams e) Identify, formulate, & solve engineering problems f) Understand professional & ethical responsibilities g) Communicate effectively h) Understand impact of engineering solutions in global, economic, environmental, & societal context i) Recognize need for & be able to engage in lifelong learning j) Know contemporary issues k) Use techniques, skills, modern tools for engineering practices	1. Objective tests 2. Essay questions tests 3. Peer tutoring based 4. Simulation based 5. Design oriented 6. Problem based 7. Experiential (project based) 8. Lab work or field work based 9. Presentation based 10. Case Studies based 11. Role-play based 12. Portfolio based	A. Questions should have: B. Definitions, Principle of operation or philosophy of concept. C. Mathematical treatment, derivations, analysis, synthesis, numerical problems with inference. D. Design oriented problems E. Troubleshooting type of questions F. Applications related questions G. Brain storming questions	

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**ELECTROMAGNETIC FIELDS**

Electromagnetic fields is the foremost pre-requisite course for most of the subjects in Electrical Engineering. Either in the enunciation of basics of electrical elements R, L and C that are the building blocks of any electrical device or in the illustration of Energy transfer from mechanical to electrical and vice versa its role is crucial. This course also includes the famous works of Coulomb, Ampere, Faraday, Maxwell etc. to the field of Electrical Engineering.

**UNIT – I Electrostatics:****Objective:**

To study the production of electric field and potentials due to different configurations of static charges.

Electrostatic Fields – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge – Work done in moving a point charge in an electrostatic field – Electric Potential – Properties of potential function – Potential gradient – Gauss's law — Maxwell's first law,  $\text{div}(\mathbf{D}) = \rho_v$  Laplace's and Poisson's equations and Solution of Laplace's equation in one variable.

**Outcome:** Ability to calculate electric field and potentials using Gauss's law or solving Laplace's or Poisson's equations.

**UNIT – II Conductors – Dielectrics and Capacitance:****Objective :**

To study the properties of conductors and dielectrics, calculate the capacitance of different configurations and understand the concept of conduction and convection current densities.

Electric dipole – Dipole moment – potential and EFI due to an electric dipole – Torque on an Electric dipole in an electric field – Behaviour of conductors in an electric field – Conductors and Insulators

Polarization – Boundary conditions between conduction to Dielectric and dielectric to dielectrics capacitance – capacitance of parallel plates, spherical and coaxial cables with composite dielectrics –Energy stored and energy density in a static electric field – Current density – conduction and Convection current densities – Ohm's law in point form – Equation of continuity.

**Outcome:** Learn how to calculate capacitance, energy stored in dielectrics and get's the concept of conduction and convection currents.

### **UNIT – III Magneto statics and Ampere's Law:**

#### **Objective:**

To study the magnetic fields produced by currents in different configurations, application of ampere's law and the Maxwell's second and third equations.

Static magnetic fields – Biot-Savart's law – Oesterd's experiment - Magnetic field intensity (MFI) – MFI due to a straight current carrying filament – MFI due to circular, square and solenoid current – Carrying wire – Relation between magnetic flux, magnetic flux density and MFI – Maxwell's second Equation,  $\text{div}(\mathbf{B})=0$  – Ampere's circuital law and its applications viz. MFI due to an infinite sheet of current and a long filament carrying conductor – Point form of Ampere's circuital law –Field due to a circular loop, rectangular and square loops, Maxwell's third equation,  $\text{Curl}(\mathbf{H})=\mathbf{J}$ .

#### **Outcome:**

Ability to find magnetic field intensity due to current, the application of ampere's law and the Maxwell's second and third equations.

### **UNIT – IV Force in Magnetic fields:**

#### **Objective :**

To study the magnetic force and torque through Lorentz force equation in magnetic field environment like conductors and other current loops.

Magnetic force - Moving charges in a Magnetic field – Lorentz force equation – force on a current element in a magnetic field – Force on a straight and a long current carrying conductor in a magnetic field – Force between two straight long and parallel current carrying conductors – Magnetic dipole and dipole moment – a differential current loop as a magnetic dipole – Torque on a current loop placed in a magnetic field.

#### **Outcome:**

Students can calculate the magnetic forces and torque produced by currents in magnetic field.

### **UNIT – V Self and Mutual inductance:**

#### **Objective :**

To develop the concept of self and mutual inductances and the energy stored.

Self and Mutual inductance – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

**Outcome:**

Will be able to calculate self and mutual inductances and the energy stored in the magnetic field.

**UNIT – VI Time Varying Fields:****Objective :**

To study time varying and Maxwell's equations in different forms and Maxwell's fourth equation for the induced Emf.

Time varying fields – Faraday's laws of electromagnetic induction – Its integral and point forms – Maxwell's fourth equation,  $\text{Curl } (\mathbf{E}) = -\partial \mathbf{B} / \partial t$  – Statically and Dynamically induced EMFs – Simple problems -Modification of Maxwell's equations for time varying fields – Displacement current – Poynting Theorem and Poynting vector.

**Outcome:**

Students will gain knowledge on time varying fields and get ability to calculate induced Emf. Concepts of displacement current and Poynting vector and associated problems are solved.

**TEXT BOOKS:**

1. "Engineering Electromagnetics" by William H. Hayt & John. A. Buck Mc. Graw-Hill Companies, 7<sup>th</sup> Edition. 2006.

**REFERENCE BOOKS**

1. "Principles of Electro Magnetics" by Sadiku, Oxford Publications, 4<sup>th</sup> edition.
2. "Introduction to Electro Dynamics" by D J Griffiths, Prentice-Hall of India Pvt. Ltd., 2<sup>nd</sup> edition.
3. "Electromagnetic Field Theory" by Yaduvir Singh, Pearson.
4. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan, Oxford higher education.
5. Electro magnetism : Problems with solutions by Ashutosh Pramanik, PHI Publications.

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**ELECTRICAL MACHINES – I****Preamble:**

This is a basic course on rotating electrical machines. This course covers the topics related to principles, performance, applications and design considerations of dc machines.

**Learning objectives:**

- Appreciate the principles of electromagnetic energy conversion and understand the construction details of DC machine.
- Understand the principle of operation and performance of DC generators.
- Learn the characteristics and performance of DC generators.
- Learn the characteristics and performance of DC motors.
- Learn the speed control and testing methods of DC motors.
- Learn the basic ideas of design of DC machines.

**UNIT-I:****Electromechanical Energy Conversion**

Introduction to S.I Units - principles of electromechanical energy conversion – forces and torque in magnetic field systems – energy balance- singly excited machine- magnetic force - co-energy – multi excited magnetic field system-construction features of conventional and modern DC machines.

**UNIT-II:****D.C. Generators – I**

Principle of operation – E.M.F equation- armature windings – lap and wave windings – armature reaction –cross magnetizing and de-magnetizing AT/pole –commutation process – methods of improving commutation – compensating windings – Interpoles.

**UNIT-III:****D.C. Generators – II**

Methods of excitation- self excited and separately excited-types of generators build-up of emf - open circuit characteristics-critical field resistance-critical speed-causes for failure to self excitation-remedial measures – Internal and



external characteristics of separately excited, shunt, series, compound generators-applications, losses and efficiency.

#### **UNIT-IV:**

##### **D.C. Motors**

Principle of operation – back E.M.F - torque equation –characteristics of shunt, series and compound motors – armature reaction and commutation - losses and efficiency- speed torque characteristics-applications of dc motors.

Starting by 3 point and 4 point starters – protective devices.

#### **UNIT-V:**

##### **Speed Control and Testing of D.C. Machines**

Speed control by armature voltage and field flux control – testing of DC machines - brake test, Swinburne's method – principle of regenerative or Hopkinson's method - retardation test -- separation of losses – methods of electrical braking: plugging, dynamic and regenerative.

#### **UNIT-VI:**

##### **Design of D.C. Machines**

Design concept - output equation - choice of specific electric and magnetic loadings – separation of D and L - estimation of number of conductors/ turns - coils - armature slots – conductor dimension – slot dimension - choice of number of poles – length of air gap.

##### **Learning outcomes:**

- i. Able to explain the concepts of electromagnetic energy conversion.
- ii. Able to explain the operation of dc generator, armature reaction and commutation.
- iii. Able to analyze the characteristics and performance of dc generators.
- iv. Able to explain the torque developed and performance of dc motors.
- v. Able to analyze the speed control and testing methods of dc motors.
- vi. Able to propose design aspects of a dc machine.

##### **TEXT BOOKS:**

- 1 Electrical Machines – P.S. Bhimbra, Khanna Publishers
2. Electric Machinery by A.E.Fitzgerald, Charles kingsley, Stephen D.Umans, TMH

**REFERENCE BOOKS:**

1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria & Sons.
2. Electrical Machines by R.K. Rajput, Lakshmi publications, 5<sup>th</sup> edition.
3. The Performance and Design of DC machines - Albert E. Clayton.
4. Electrical Machine Design by A.K. Sawhney, Dhanpat Rai & Sons publications.
5. Electric Machines by Mulukutla S.Sarma&Mukesh K.Pathak, CENGAGE Learning.

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**THERMAL AND HYDRO LAB****Course Objective:**

To impart practical knowledge on the performance evaluation methods of various internal combustion engines, flow measuring equipment and hydraulic turbines and pumps.

**NOTE:** To conduct a minimum of 12 experiments by conducting a minimum of six from each section.

**SECTION A - THERMAL ENGINEERING LAB**

1. I.C. Engines valve / port timing diagrams.
2. I.C. Engines performance test on 4 -stroke Diesel engine.
3. I.C. Engines performance test on 2-stroke petrol engine.
4. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine
5. Determination of FHP by retardation and motoring test on IC engine
6. I.C. Engines heat balance on petrol / Diesel engines.
7. Economical speed test of an IC engine
8. Study of boilers

**SECTION B – HYDRAULIC MACHINES LAB**

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Reciprocating Pump.
7. Calibration of Venturimeter.
8. Calibration of Orifice meter.
9. Determination of loss of head due to sudden contraction in a pipeline.

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**ELECTRICAL CIRCUITS LAB**

Any 10 of the following experiments are to be conducted:

- 1) Verification of Thevenin's and Norton's Theorems.
- 2) Verification of Superposition theorem and Maximum Power Transfer Theorem.
- 3) Verification of Compensation Theorem.
- 4) Verification of Reciprocity, Millmann's Theorems.
- 5) Locus Diagrams of RL and RC Series Circuits.
- 6) Series and Parallel Resonance
- 7) Determination of Self, Mutual Inductances and Coefficient of coupling.
- 8) Z and Y Parameters
- 9) Transmission and hybrid parameters
- 10) Measurement of Active Power for Star and Delta connected balanced loads.
- 11) Measurement of Reactive Power for Star and Delta connected balanced loads.
- 12) Measurement of 3-phase Power by two Wattmeter Method for unbalanced loads.