

## 1.5 FUNDAMENTAL OF ELECTRICAL & ELECTRONICS ENGG

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### RATIONALE

A diploma holder may be involved in various jobs ranging from preventive maintenance of electrical installation to fault location. In addition, he/she may be working in testing laboratories where he/she uses measuring instruments. To carry out these and similar jobs effectively, knowledge of basic concepts, principles and their applications is very essential. This course will enable the students to understand the basic concepts and principles of DC and AC fundamental, ac circuits, batteries, electromagnetic induction, voltage and current sources etc. This subject gives the knowledge of fundamental concepts and principles of basic electronics and aims at providing the students with basic understanding of various types of materials such as conductors, semiconductors and insulators, extrinsic and intrinsic semi-conductors, p-n junction, need of rectifiers, significance and use of filters in rectifiers, basic structure and working principle of LEDs, LCD; working of Transistors in various configurations; fundamental knowledge of HTs and MOSFETs etc. and their applications. The teacher should give emphasis on understanding of concepts by explaining the various terms used in the subject. Practical exercises have been included in order to reinforce various concepts

### LEARNING OUTCOMES

After undergoing the subject, the students will be able to:

- Identify and able to take readings on various electrical equipments(voltmeter, ammeter, CRO, wattmeter, multi-meter)
- Determination of voltage-current relationship in a DC circuit under specific physical conditions
- Measure resistance of an ammeter and a voltmeter
- Verify DC circuits (Thevenin and Norton's Theorem), Superposition nodal analysis, Maximum Power Transfer Theorem
- Verify Kirchhoff's Current and Voltage Laws in a dc circuit
- Find the ratio of inductance of a coil having air-core and iron-core respectively and to observe the effect of introduction of a magnetic core on coil inductance
- Measure power and power factor in a single phase R-L-C. Circuit and calculation of active and reactive powers in the circuit. After undergoing the subject, the students will be able to take readings on various electronics equipments(multimeter, CRO, signal generator, LCR meter)
- Plot the VI characteristics of pn junction diode and Zener diode
- Measure voltage gain, input and output impedance in a single state CE amplifier circuit.
- Fabricate half wave, full wave and bridge rectifier and observe waveforms of each
- Plot the waveforms of the rectifier circuit with different filters
- Plot input and output characteristics of transistor in CB and CE mode
- Plot the characteristics of FET based amplifier

- Measure voltage gain, input and output impedance in a single stage CE amplifier circuit. take readings on various electronics equipments(multi meter, CRO, signal generator, LCR meter)

## DETAILED CONTENTS

1. Overview of DC Circuits (05 hrs)
  - 1.1 Simple problems on series and parallel combination of resistors and capacitors with their wattage consideration,
  - 1.2 Application of Kirchhoff's current law and Kirchhoff's voltage law to simple circuits. Star - Delta connections and their conversion.
  
2. DC Circuit Theorems (05 hrs)

Thevenin's theorem, Norton's theorem, application of network theorems in solving D.C. circuit problems. Superposition nodal analysis, Mesh analysis, Maximum Power Transfer Theorem.
  
3. Voltage and Current Sources (04 hrs)
  - 3.1 Concept of voltage source, symbol and graphical representation characteristics of ideal and practical sources.
  - 3.2 Concept of current sources, symbol, characteristics and graphical representation of ideal and practical current sources.
  
4. Semiconductor Physics (06 hrs)
  - 4.1 Review of basic atomic structure and energy levels, concept of insulators, conductors and semi conductors, atomic structure of Germanium (Ge) and Silicon (Si), covalent bonds
  - 4.2 Concept of intrinsic and extrinsic semi conductor, process of doping.
  - 4.3 Energy level diagram of conductors, insulators and semi conductors; minority and majority charge carriers.
  - 4.4 P and N type semiconductors and their conductivity, effect of temperature on conductivity of intrinsic semi conductors.
  
5. Semiconductor Diode (08 hrs)
  - 5.1 PN junction diode, mechanism of current flow in PN junction, forward and reverse biased PN junction, potential barrier, drift and diffusion currents, depletion layer, concept of junction capacitance in forward and reverse biased condition.
  - 5.2 V-I characteristics, static and dynamic resistance and their value calculation from the characteristics.
  - 5.3 Application of diode as half-wave, full wave and bridge rectifiers. Peak Inverse Voltage, rectification efficiencies and ripple factor calculations, shunt capacitor filter, series inductor filter, LC and  $\pi$  filters.
  - 5.4 Types of diodes, characteristics and applications of Zener diodes. Zener and avalanche breakdown

## 6. Electro Magnetic Induction

(06 hrs)

- 6.1 Concept of electro-magnetic field produced by flow of electric current, magnetic circuit, concept of magneto-motive force (MMF), flux, reluctance, permeability, analogy between electric and magnetic circuit.
- 6.2 Faraday's laws of electro-magnetic induction, principles of self and mutual induction, self and mutually induced e.m.f, simple numerical problems.
- 6.3 Concept of current growth, decay and time constant in an inductive (RL) circuit.
- 6.4 Energy stored in an inductor, series and parallel combination of inductors.

## 7. Batteries

(05 hrs)

- 7.1 Basic idea of primary and secondary cells
- 7.2 Construction, working principle and applications of Lead-Acid, Nickel-Cadmium and Silver-Oxide batteries
- 7.3 Charging methods used for lead-acid battery (accumulator)
- 7.4 Care and maintenance of lead-acid battery
- 7.5 Series and parallel connections of batteries
- 7.6 General idea of solar cells, solar panels and their applications
- 7.7 Introduction to maintenance free batteries

## 8. AC Fundamentals

(05 hrs)

- 8.1 Concept of alternating quantities
- 8.2 Difference between ac and dc
- 8.3 Concepts of: cycle, frequency, time period, amplitude, instantaneous value, average value, r.m.s. value, maximum value, form factor and peak factor.
- 8.4 Representation of sinusoidal quantities by phasor diagrams.
- 8.5 Equation of sinusoidal wave form for an alternating quantity and its derivation
- 8.6 Effect of alternating voltage applied to a pure resistance, pure inductance and pure capacitance.

## 9. AC Circuits

(06 hrs)

- 9.1 Concept of inductive and capacitive reactance
- 9.2 Alternating voltage applied to resistance and inductance in series.
- 9.3 Alternating voltage applied to resistance and capacitance in series.
- 9.4 Introduction to series and parallel resonance and its conditions
- 9.5 Power in pure resistance, inductance and capacitance, power in combined RLC circuits. Power factor, active and reactive power and their significance, definition and significance of power factor.
- 9.6 Definition of conductance, susceptance, admittance, impedance and their units

## 10. Introduction to Bipolar-Transistors

(06 hrs)

10.1 Concept of a bipolar transistor, its structure, PNP and NPN transistors, their symbols and mechanism of current flow; Current relations in a transistor; concept of leakage current;

10.2 CB, CE, CC configurations of a transistor; Input and output characteristics in CB and CE configurations; input and output dynamic resistance in CB and CE configurations; Current amplification factors. Comparison of CB, CE and CC Configurations;

10.3 Transistor as an amplifier in CE Configuration; concept of DC load line and calculation of current gain and voltage gain using DC load line.

## 11. Transistor Biasing Circuits

(04 hrs)

Concept of transistor biasing and selection of operating point. Need for stabilization of operating point. Different types of biasing circuits.

## 12. Field Effect Transistors

(05 hrs)

Construction, operation and characteristics of FETs and their applications.

12.1 Construction, operation and characteristics of a MOSFET in depletion and enhancement modes and its applications.

12.2 CMOS - advantages and applications

12.3 Comparison of JFET, MOSFET and BJT.

## 13. Introduction to Electrical Machines

(05 hrs)

13.1 Transformers : Principal of operation, construction detail of single phase transformer, turns ratio , efficiency, loses in a transformer.

13.2 DC machine : principal of operation, construction of DC motor and generator, Characteristics of different types of DC machines , Starter .

13.3 AC machines : Principal and working of synchronous machines, single phase induction motor

## LIST OF PRACTICALS

1. Operation and use of measuring instruments viz voltmeter, ammeter, CRO, Wattmeter, multi-meter and other accessories

2. Measurement of resistance of an ammeter and a voltmeter

3. Verification of following Theorems:-

a. Thevenin's theorem,

b. Norton's theorem,

4. Observation of change in resistance of a bulb in hot and cold conditions, using voltmeter and ammeter.

5. Verification of Krichhoff's Current and Voltage Laws in a dc circuit

6. To find the ratio of inductance of a coil having air-core and iron-core respectively and

to find the effect of introduction of ferromagnetic core on coil inductance

7. Charging and testing of a lead - acid storage battery.
8. Measurement of power and power factor in a single phase R-.I.-.C. circuit and calculation of active and reactive powers in the circuit.
9. Plotting of V-I characteristics of a PN junction diode & Zener diode
  
10. Observe the output of waveform using
  - a. Half-wave rectifier circuit using one diode
  - b. Full-wave rectifier circuit using two diodes
  - c. Bridge-rectifier circuit using four diodes
11. Plotting of the wave shape of full wave rectifier with
  - a. Shunt capacitor filter
  - b. Series inductor filter
12. Plotting of input and output characteristics and calculation of parameters of transistors in CE configuration.
13. Plotting of input and output characteristics and calculation of parameters of transistors in CB configuration.
14. Plotting of V-I characteristics of a FET.
15. To determine the efficiency of single phase Transformer