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Short Notes — Fundamentals of Electrical & Electronics Engineering

BTEUP Diploma • 1st Semester (First Year — Common Curriculum, All 41 Branches) •

Short Notes

Session 2026–27

Short Revision Notes — prepared by KAMALDNP Academy from the official BTEUP 2026-27 syllabus. This is NOT a BTEUP board paper or publication.

These short notes cover the four units of **Fundamentals of Electrical & Electronics Engineering** from the BTEUP 2026-27 first-semester syllabus, common to all diploma branches. Each unit gives tight, exam-focused points on every topic named in the syllabus — definitions, formulas with units, simple calculations and the differences examiners usually ask about.

Use these notes for **revision**: read a unit, cover the page and try to recall each definition and formula, then attempt the likely question at the end of the unit. These are revision notes prepared by KAMALDNP Academy, not a BTEUP publication, so always match your final preparation with the official syllabus and your class notes.

Basic Electrical Concepts

Topics: Charge, current, voltage, resistance and power; Ohm's law; series and parallel circuits.

Charge, current, voltage, resistance and power

Electric charge (Q) is the basic property of matter carried by electrons and protons; its unit is the **coulomb (C)**. **Electric current (I)** is the rate of flow of charge through a conductor: **I**

= Q / t , measured in **ampere (A)**. A current of 1 A means 1 coulomb of charge passes every second.

Voltage (V), or potential difference, is the work done per unit charge in moving it between two points: $V = W / Q$, measured in **volt (V)**. It is the "pressure" that pushes current through a circuit, supplied by a battery or generator.

Resistance (R) is the opposition offered to the flow of current; unit **ohm (Ω)**. Resistance of a wire increases with its length and temperature and decreases with larger thickness (area): $R = \rho L/A$, where ρ is the resistivity of the material.

Electric power (P) is the rate of doing electrical work: $P = V \times I$, measured in **watt (W)**. Electrical energy consumed = $P \times t$, measured commercially in kWh ("units").

Ohm's law

Ohm's law states that, at constant temperature, the current flowing through a conductor is directly proportional to the voltage applied across it. In formula form:

$$V = I \times R \quad (\text{voltage} = \text{current} \times \text{resistance})$$

The same formula rearranged gives $I = V / R$ and $R = V / I$. Ohm's law leads to two more useful power formulas: $P = V \times I = I^2 R = V^2 / R$.

Example: A resistor of 20Ω is connected across a 100 V supply. Current $I = V / R = 100 / 20 = 5 \text{ A}$. Power consumed $P = V \times I = 100 \times 5 = 500 \text{ W}$.

Conditions and limits: Ohm's law holds for metallic conductors at constant temperature. It does not hold directly for devices whose resistance changes strongly with voltage or temperature, such as a heating filament at very different temperatures or a semiconductor diode. Most simple exam numericals use $V = IR$ directly, so always write the given values, the formula, the substitution and the answer with its unit.

Series and parallel circuits

Resistors can be joined in two basic ways.

Series connection — resistors are joined end to end in one path. The **same current** flows through every resistor, the total voltage divides among them, and the equivalent resistance is the sum:

$$R = R_1 + R_2 + R_3$$

Parallel connection — resistors are joined between the same two points. The **same voltage** appears across every resistor, the total current divides among the branches, and the equivalent resistance is given by:

$1/R = 1/R_1 + 1/R_2 + 1/R_3$ The equivalent resistance is always **less than the smallest** branch resistor.

Example: $2\ \Omega$ and $4\ \Omega$ in series give $R = 6\ \Omega$. In parallel, $R = (2 \times 4)/(2 + 4) = 8/6 \approx 1.33\ \Omega$. House wiring is parallel, so every appliance gets the full supply voltage and works independently; decorative series lights fail together when one bulb fuses — a common exam comparison point.

Likely question: State and explain Ohm's law. Three resistors of $2\ \Omega$, $4\ \Omega$ and $6\ \Omega$ are connected (a) in series and (b) in parallel across a $12\ \text{V}$ supply. Find the equivalent resistance and the total current in each case.

AC & DC

Topics: Direct current and alternating current; single-phase AC in brief; transformers in brief.

Direct current and alternating current

Direct current (DC) flows in **one direction only** and its value stays (nearly) constant with time. Sources of DC: cells and batteries, DC generators and rectified (converted) supply. DC is used in torch and battery circuits, electronic devices, mobile charging and electroplating.

Alternating current (AC) changes its **direction and magnitude continuously** in a regular cycle, shown by a sine-wave graph. Sources: alternators (AC generators) and the household mains supply. The number of cycles completed in one second is the **frequency**, measured in hertz (Hz).

Key differences:

- Direction — DC: one direction; AC: reverses regularly.
- Graph with time — DC: a straight line; AC: a sine wave.
- Voltage change — AC voltage can be raised or lowered easily by a transformer; DC cannot.
- Transmission — AC is preferred for long-distance power supply because stepping up voltage reduces losses.

Most electronic circuits work internally on DC, obtained from AC mains by a rectifier circuit in the adaptor or power supply.

Single-phase AC in brief

Single-phase AC is an alternating supply with one voltage waveform (one sine wave), supplied through two wires — phase (live) and neutral. It is the supply used in homes and small workshops for lights, fans, television, computers and small motors.

Important terms of an AC wave:

- **Cycle** — one complete set of positive and negative values.
- **Frequency (f)** — cycles per second, in hertz (Hz).

- **Time period (T)** — time of one cycle; $T = 1/f$.
- **Amplitude** — the maximum value reached by the wave.
- **RMS value** — the effective value of AC, the value a voltmeter reads; for a sine wave, $\text{RMS} = \text{maximum value} / \sqrt{2} \approx 0.707 \times \text{maximum}$.

The supply voltage quoted for AC (such as the value printed on appliances) is always the RMS value. Three-phase AC, with three waveforms, is used for large motors and industrial loads; at this level only single-phase is needed in brief.

Transformers in brief

A **transformer** is a static (no moving parts) device that changes the level of AC voltage — raising it (step-up) or lowering it (step-down) — without changing frequency. It works on the principle of **mutual induction**: an alternating current in one coil produces a changing magnetic flux in the iron core, which induces a voltage in the second coil.

Construction in brief: two windings of insulated wire — the **primary** (input) and **secondary** (output) — wound on a laminated iron core. The voltage ratio is fixed by the turns ratio:

$$V_2 / V_1 = N_2 / N_1 \quad (N = \text{number of turns})$$

If $N_2 > N_1$, the transformer is step-up; if $N_2 < N_1$, it is step-down. An ideal transformer has no power loss, so input power = output power ($V_1 I_1 = V_2 I_2$).

Important point: a transformer works **only on AC**, because DC produces constant flux and induces no voltage in the secondary. Uses: power transmission (step-up), distribution and phone chargers (step-down).

Likely question: Differentiate between alternating current (AC) and direct current (DC), giving sources and uses of each.

Electronic Components

Topics: Resistors, capacitors, inductors; diodes and transistors in brief.

Resistors, capacitors, inductors

These are the three basic **passive components** of electronic circuits; each behaves differently with current and voltage.

Resistor — opposes the flow of current and converts electrical energy into heat. Value in **ohm (Ω)**; identified by colour bands printed on its body. Used to limit current and divide voltage.

Capacitor — stores electrical energy in the form of charge between two conducting plates separated by an insulating material (dielectric). Value in **farad (F)**, practically microfarad

(μF). It blocks steady DC but passes AC; used in filters, power supplies and motor starting. Charging/discharging is gradual, not instant.

Inductor — a coil of wire that stores energy in a magnetic field and opposes any change in current through it. Value in **henry (H)**. Used in filters, chokes, transformers and radio tuning circuits.

Memory line: resistor opposes current, capacitor opposes change of voltage (stores charge), inductor opposes change of current.

Diodes and transistors in brief

Diode — a two-terminal semiconductor device (terminals: anode and cathode) made from a p-n junction. It allows current to flow **mainly in one direction** — from anode to cathode — when forward biased, and blocks it in reverse bias. This one-way property is used in **rectifiers**, which convert AC into DC in power supplies and chargers. A special diode, the **LED**, gives out light when forward current passes through it.

Transistor — a three-terminal semiconductor device (terminals: base, collector and emitter in a BJT). A small current at the base controls a much larger current between collector and emitter, so the transistor works as:

- an **amplifier** — making weak signals stronger, as in audio equipment, and
- a **switch** — turning circuits fully ON or OFF, the basis of digital circuits and computers.

Diodes and transistors are **active components** — unlike resistors, capacitors and inductors, they can control and amplify signals, which is why they form the base of all modern electronics.

Likely question: Write short notes on any two: (i) capacitor, (ii) inductor, (iii) diode.

Measuring Instruments

Topics: Multimeter; ammeter and voltmeter; measuring voltage, current and resistance.

Multimeter

A **multimeter** is a single instrument that measures several electrical quantities — voltage, current and resistance — so it is also called an **AVO meter** (Ampere-Volt-Ohm). It has two test leads: **black (common/negative)** and **red (positive)**, and a rotary selector switch to choose the quantity and range. Digital multimeters show the reading directly as numbers; analog types use a pointer and scale.

General method:

- Insert the black lead in the COM socket and the red lead in the proper socket for the quantity.

- Turn the selector to the required function (V, A or Ω) and a suitable range.
- If the value is unknown, start on the **highest range** and come down — this protects the meter.
- Connect the leads correctly (parallel for voltage, series for current, component removed for resistance) and read the display.

The multimeter is the most-used instrument in electrical and electronics practical work and fault finding.

Ammeter and voltmeter

An **ammeter** measures electric current in a circuit; an **voltmeter** measures the voltage (potential difference) between two points. The way each is connected is opposite, and this difference is a favourite exam question.

Ammeter:

- Connected in **series** in the circuit, so the full circuit current passes through it.
- Has very **low resistance**, so that it does not reduce the current it is measuring.
- Unit on the dial: ampere (A) or milliampere (mA).

Voltmeter:

- Connected in **parallel** across the component or points whose voltage is to be measured.
- Has very **high resistance**, so that it draws almost no current from the circuit.
- Unit on the dial: volt (V).

Warning: never connect an ammeter directly across a supply (in parallel) — its low resistance causes a near short circuit and can damage the meter and the supply.

Measuring voltage, current and resistance

The correct connection and one main precaution decide whether a measurement is right or the meter is damaged.

Measuring voltage: set the multimeter to the V range (AC or DC as required), connect the probes **in parallel** across the component — red to the higher-potential point, black to the lower. The circuit may remain switched ON.

Measuring current: switch the circuit OFF, **break the circuit** and insert the meter **in series** so that the whole current passes through it, then switch ON and read. The red lead may need the separate high-current socket for large currents.

Measuring resistance: the component must be **removed from the circuit and fully discharged** (supply OFF — never measure resistance in a live circuit). Set the Ω range, touch the probes across the component and read. Do not touch both probe tips with your fingers, as body resistance affects the reading.

In every case: select the right quantity and type (AC/DC), start from the highest range when unsure, and note the unit of the reading.

Likely question: How is a multimeter used to measure voltage, current and resistance? State the precautions to be observed in each measurement.

Quick Revision — One Line Each

- Current is the rate of flow of charge: $I = Q/t$; unit ampere (A).
- Voltage is work done per unit charge: $V = W/Q$; unit volt (V).
- Resistance opposes current; unit ohm (Ω); it increases with length and decreases with a thicker wire.
- Ohm's law: $V = IR$ — valid for a conductor at constant temperature.
- Power: $P = VI = I^2R = V^2/R$; unit watt (W). Energy = $P \times t$, measured in kWh (units).
- Resistors in series: $R = R_1 + R_2 + R_3$; same current flows through all of them.
- Resistors in parallel: $1/R = 1/R_1 + 1/R_2 + 1/R_3$; the total is always less than the smallest resistor.
- DC flows in one direction only (battery); AC reverses direction regularly (mains supply).
- A transformer works only on AC, on mutual induction; it changes voltage level, not power or frequency.
- A diode allows current mainly in one direction; a transistor can amplify and switch.
- Ammeter: connected in series, has very low resistance. Voltmeter: connected in parallel, has very high resistance.
- A multimeter measures voltage, current and resistance — always start on the highest range for an unknown value.

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