EE 302
Electronic Equipment Repair

5.0 Power Supply

http://modul2poli.blogspot.com/
At the end of the sessions:

5.1 Understand the principle of power supply block diagram

- Explain the function of power supply.
- Draw block diagram of linear DC regulated power supply
- Describe function of each block of switch mode power supply
- Draw block diagram of switch mode power supply
- Describe function of each block of switch mode power supply

http://modul2poli.blogspot.com/
Introduction to Power Supply

A **power supply** is a device that supplies electric power to an electrical load. The term is most commonly applied to electric power converters that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy.

A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. Depending on its design, a power supply may obtain energy from:

- Electrical energy transmission systems. Common examples of this include power supplies that convert **AC** line voltage to **DC** voltage.

http://modul2poli.blogspot.com/
Linear DC Regulated Power Supply

DC Power Supply

An AC powered unregulated power supply usually uses a transformer to convert the voltage from the wall outlet (mains) to a different, nowadays usually lower, voltage. If it is used to produce DC, a rectifier is used to convert alternating voltage to a pulsating direct voltage, followed by a filter, comprising one or more capacitors, resistors, and sometimes inductors, to filter out (smooth) most of the pulsation. A small remaining unwanted alternating voltage component at mains or twice mains power frequency (depending upon whether half- or full-wave rectification is used) — ripple — is unavoidably superimposed on the direct output voltage.

http://modul2poli.blogspot.com/
Linear DC Regulated Power Supply

**Schematic** and Block Diagram of Linear DC regulated Power Supply

http://modul2poli.blogspot.com/
Linear DC Regulated Power Supply

- Schematic and **Block Diagram** of Linear DC regulated Power Supply

http://modul2poli.blogspot.com/
Switch Mode Power Supply

Switched-mode power supplies are usually regulated, and to keep the output voltage constant, the power supply employs a feedback controller that monitors current drawn by the load. The switching duty cycle increases as power output requirements increase.

In a **switched-mode power supply** (SMPS), the AC mains input is directly rectified and then filtered to obtain a DC voltage. The resulting DC voltage is then switched on and off at a high frequency by electronic switching circuitry, thus producing an AC current that will pass through a high-frequency transformer or inductor. Switching occurs at a very high frequency (typically 10 kHz — 1 MHz), thereby enabling the use of transformers and filter capacitors that are much smaller, lighter, and less expensive than those found in linear power supplies operating at mains frequency. After the inductor or transformer secondary, the high frequency AC is rectified and filtered to produce the DC output voltage. If the SMPS uses an adequately insulated high-frequency transformer, the output will be electrically isolated from the mains; this feature is often essential for safety.

http://modul2poli.blogspot.com/
Switch Mode Power Supply

Some switch-mode power supplies use filters or additional switching stages in the incoming rectifier circuit to improve the waveform of the current taken from the AC line. This adds to the circuit complexity. Many computer power supplies built in the last few years now include power factor correction built right into the switched-mode supply, and may advertise the fact that they offer 1.0 power factor.

SMPS Block diagram:

http://modul2poli.blogspot.com/
Switch Mode Power Supply

SMPS Block diagram:

Input rectifier stage
- If the SMPS has an AC input, then the first stage is to convert the input to DC. This is called rectification. A SMPS with a DC input does not require this stage.
- In some power supplies (mostly computer ATX power supplies), the rectifier circuit can be configured as a voltage doubler by the addition of a switch operated either manually or automatically. This feature permits operation from power sources that are normally at 115 V or at 230 V. The rectifier produces an unregulated DC voltage which is then sent to a large filter capacitor. The current drawn from the mains supply by this rectifier circuit occurs in short pulses around the AC voltage peaks.

http://modul2poli.blogspot.com/
Switch Mode Power Supply

SMPS Block diagram:

- **Inverter @ Chopper**
  - The inverter stage converts DC, whether directly from the input or from the rectifier stage described above, to AC by running it through a power oscillator, whose output transformer is very small with few windings at a frequency of tens or hundreds of kilohertz. The frequency is usually chosen to be above 20 kHz, to make it inaudible to humans. The switching is implemented as a multistage (to achieve high gain) MOSFET amplifier.

Note: MOSFETs are a type of transistor with a low on-resistance and a high current-handling capacity.
Switch Mode Power Supply

SMPS Block diagram:

- **Voltage converter and output rectifier**
  - If the output is required to be isolated from the input, as is usually the case in mains power supplies, the inverted AC is used to drive the primary winding of a high-frequency transformer. This converts the voltage up or down to the required output level on its secondary winding. The output transformer in the block diagram serves this purpose.
  - The rectified output is then smoothed by a filter consisting of inductors and capacitors. For higher switching frequencies, components with lower capacitance and inductance are needed.

http://modul2poli.blogspot.com/
Interpret the power supply circuit diagram

- Linear DC Regulator power supply using transistor.

- The voltage produced by an unregulated power supply will vary depending on the load and on variations in the AC supply voltage. For critical electronics applications, a linear regulator may be used to set the voltage to a precise value, stabilized against fluctuations in input voltage and load. The regulator also greatly reduces the ripple and noise in the output direct current. Linear regulators often provide current limiting, protecting the power supply and attached circuit from overcurrent.

- Adjustable linear power supplies are common laboratory and service shop test equipment, allowing the output voltage to be adjusted over a range. For example, a bench power supply used by circuit designers may be adjustable up to 30 volts and up to 5 amperes output. Some can be driven by an external signal, for example, for applications requiring a pulsed output.

http://modul2poli.blogspot.com/
Interpret the power supply circuit diagram

- Linear DC Regulator power supply using IC (µA 723 and 78XX / 79XX IC regulator family)

- **µA 723**
  - The µA723 is a precision integrated-circuit voltage regulator, featuring high ripple rejection, excellent input and load regulation, excellent temperature stability, and low standby current.
  - The circuit consists of a temperature-compensated reference-voltage amplifier, an error amplifier, a 150-mA output transistor, and an adjustable-output current limiter.

http://modul2poli.blogspot.com/
Interpret the power supply circuit diagram

- Linear DC Regulator power supply using IC (uA 723 and 78XX / 79XX IC regulator family)

- **78xx (e.g. 7812)**
  - The **78xx** (sometimes **L78xx, LM78xx, MC78xx**...) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost.
  - For ICs within the family, the **xx** is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx line are positive voltage regulators: they produce a voltage that is positive relative to a common ground.

http://modul2poli.blogspot.com/
Interpret the power supply circuit diagram

- Linear DC Regulator power supply using IC (uA 723 and 78XX / 79XX IC regulator family)

  - **79xx (e.g. 7912)**
  - There is a related line of 79xx devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide positive and negative supply voltages in the same circuit.

http://modul2poli.blogspot.com/
Interpret the power supply circuit diagram

- **78xx and 79xx**
- **Advantages**
  - 78xx series ICs do not require additional components to provide a constant, regulated source of power, making them easy to use, as well as economical and efficient uses of space. Other voltage regulators may require additional components to set the output voltage level, or to assist in the regulation process. Some other designs (such as a switched-mode power supply) may need substantial engineering expertise to implement.
  - 78xx series ICs have built-in protection against a circuit drawing too much power. They have protection against overheating and short-circuits, making them quite robust in most applications. In some cases, the current-limiting features of the 78xx devices can provide protection not only for the 78xx itself, but also for other parts of the circuit.

http://modul2poli.blogspot.com/
Interpret the power supply circuit diagram

- **78xx** and **79xx**
- **Disadvantages**

  - The input voltage must always be higher than the output voltage by some minimum amount (typically 2 volts). This can make these devices unsuitable for powering some devices from certain types of power sources (for example, powering a circuit that requires 5 volts using 6-volt batteries will not work using a 7805).

  - As they are based on a linear regulator design, the input current required is always the same as the output current. As the input voltage must always be higher than the output voltage, this means that the total power (voltage multiplied by current) going into the 78xx will be more than the output power provided. **The extra input power is dissipated as heat.** This means both that for some applications an adequate heatsink must be provided, and also that a (often substantial) portion of the input power is wasted during the process, rendering them less efficient than some other types of power supplies. When the input voltage is significantly higher than the regulated output voltage (for example, powering a 7805 using a 24 volt power source), this inefficiency can be a significant issue.

http://modul2poli.blogspot.com/