

## 5) Power Supplies

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A power supply is a device or system that supplies electrical or other types of energy to an output load or group of loads. The power supply converts the alternating current to the direct current which is needed by the personal computers.

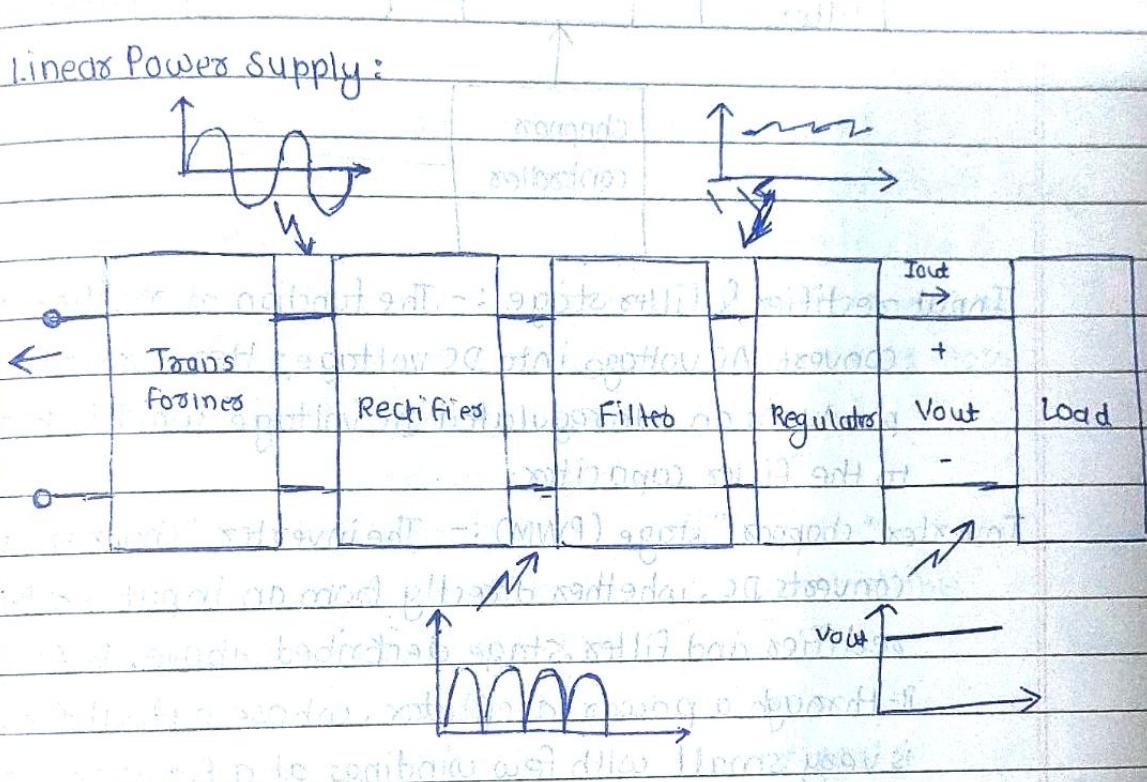
There are three types of power supplies:

① Linear Power supply:

② Switched mode power supply.

③ Uninterrupted power supply

① Linear Power Supply:



A simple AC powered linear supply uses a transformer to convert the voltage from the wall outlet (mains) to a different, usually a lower voltage.

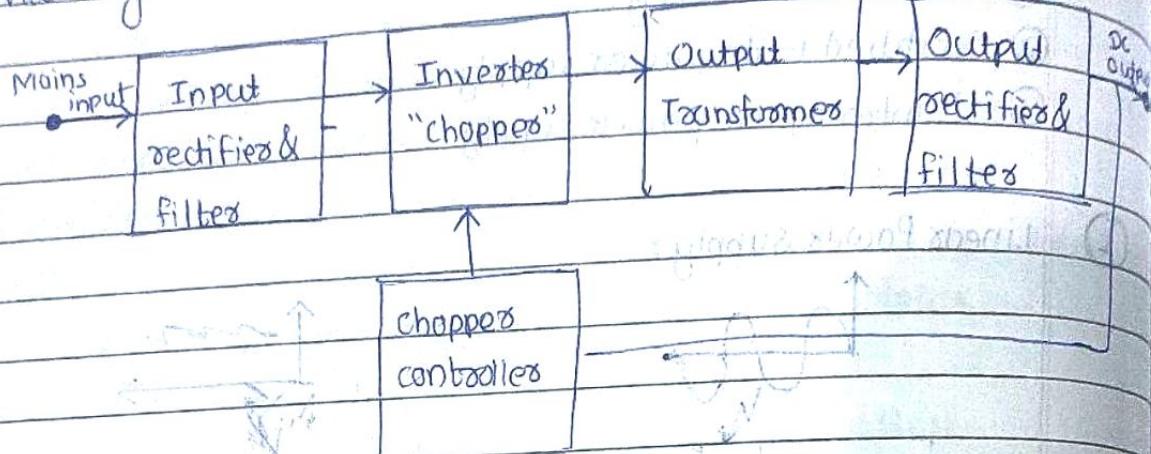
Figure shows block diagram of linear power supply, it constitutes a transformer, rectifier, filter and regulator (series or shunt type). Power supply converts the AC voltage at a transformer output into DC voltage. The regulator maintains a constant output voltage in spite of the variations in the input voltage and load current.

-09 (2) Switch Mode Power Supply (SMPS): A switch mode power supply, or SMPS, is an electronic power supply unit that incorporates a switching regulator.

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**Input rectifiers & filter stage** :- The function of rectifier is to convert AC voltage into DC voltage. Here rectifier produces an unregulated DC voltage which is then sent to the filter capacitor.

**Inverter "chopper" stage (PWM)** :- The inverter "chopper" stage converts DC, whether directly from an input or from the rectifiers and filter 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 (KHz). The frequency is usually chosen to be above 20kHz, to make it inaudible to humans.

**Output transformer** :- This converts the voltage up or down to the required output level on its secondary winding.

**Output rectifiers & filter** :- If a DC output is required, the AC output from the transformer is rectified. Here output DC voltage, rectified output by using a filter which consist of inductors and capacitors.

**Chopper controller** :- A feedback circuit monitors the output voltage and compares it with a reference voltage.

Advantages of SMPS over linear power supply:

- ① Smaller size
- ② Battery power efficiency
- ③ Lower heat generation

Disadvantages of SMPS over linear power supply:

- ① SMPS's are more complex than linear supplies.
- ② Generate high-frequency electrical noise that may need to be carefully suppressed, and have a characteristic ripple voltage at switching frequency.

SMPS and linear power supply comparison:

Parameter	SMPS	Linear Power Supply
1) Size and Weight	Large in size & heavy in weight	Small in size & light in weight
2) Efficiency	More i.e 65-75%	Less i.e 25-30%
3) RF Interference	Can cause problem if not properly shielded	None
4) Reliability	Depends on the switches	More reliable
5) Complexity	More or less	Less
6) Temperature rise	20°-40°C	50°-100°C
7) Risk of equipment damage	Very Low	High
8) Risk of electrical shock	Low	High

③ Signal description and AT & ATX (Power supply form factors):

The versions popular power supply form factors are:

- 1] AT
- 2] ATX/NLX

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**AT style SMPS:** AT style computer cabinets had a front side power button that was connected to SMPS of computer system. The two, 6-pin connectors carry DC power connections to the motherboard.

1	<input type="checkbox"/>	Power Good (White)	<input type="checkbox"/>	1 Power Good (White)
2	<input type="checkbox"/>		<input type="checkbox"/>	2 -
3	<input type="checkbox"/>		<input type="checkbox"/>	3 +12V (Yellow)
4	<input type="checkbox"/>		<input type="checkbox"/>	4 -12V (Brown)
5	<input type="checkbox"/>		<input type="checkbox"/>	5 GND (Black)
6	<input type="checkbox"/>		<input type="checkbox"/>	6 GND (Black)
7	<input type="checkbox"/>			
8	<input type="checkbox"/>		<input type="checkbox"/>	1 GND (Black)
9	<input type="checkbox"/>		<input type="checkbox"/>	2 GND (Black)
10	<input type="checkbox"/>		<input type="checkbox"/>	3 -5V (Blue)
11	<input type="checkbox"/>		<input type="checkbox"/>	4 +5V (Red)
12	<input type="checkbox"/>		<input type="checkbox"/>	5 +5V (Red)
Motherboard (male)				6 (Red)

Fig:- AT-style SMPS outputs

The power good signal is a special flag to the CPU indicating that the output voltages are stable and usable by CPU. In the absence of the power good signal CPU remains reset.

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**ATX/NLX style SMPS:** The ATX form factor is sometimes called ATX/NLX form factor. An ATX power supply does not directly connect to the system power button allowing the computer to be turned off via software.

It has three special signals:

- 1] PS-ON
- 2] 5VSB
- 3] PW-OK

- 1] The PS-ON is an input to SMPS only when this signal is low; the SMPS outputs should be **ON**. Otherwise the output should be **OFF**. This signal can be generated by software.
- 2] The 5VSB is a stand by voltage, which supplies power to special circuits even when the SMPS and the system are off.
- 3] The PW-OK is a power good signal.

		Pin 1	Pin 11		
Orange	+3.3V	<input type="checkbox"/>	<input type="checkbox"/>	+3.3V	Orange
Orange	+3.3V	<input type="checkbox"/>	<input type="checkbox"/>	-12V	Blue
Black	GND	<input type="checkbox"/>	<input type="checkbox"/>	GND	Black
Red	+5V	<input type="checkbox"/>	<input type="checkbox"/>	PS-ON	Green
Black	GND	<input type="checkbox"/>	<input type="checkbox"/>	GND	Black
Red	+5V	<input type="checkbox"/>	<input type="checkbox"/>	GND	Black
Black	GND	<input type="checkbox"/>	<input type="checkbox"/>	GND	Black
Gray	PW-OK	<input type="checkbox"/>	<input type="checkbox"/>	-5V	White
Purple	+5 VSB	<input type="checkbox"/>	<input type="checkbox"/>	+5V	Red
Yellow	+12V	<input type="checkbox"/>	<input type="checkbox"/>	+5V	Red
		Pin 10	Pin 20		

Use of output voltages of ATX SMPS: (Read from textbook)

Not imp for exam.

Types of ATX form factors: (Read detail from text book) Not imp for exam

1] ATX    2] WTX    3] AMD GES

4] EPS12V    5] ATX 12V

• ATX 12V 1.3

• ATX 12V 2.0

• ATX 12V 2.2

④

Power supply characteristics: →

1] Wattage : The total maximum output of the power supply is watt. Computer supplies are rated based on their maximum output power. Typical power ranges are from 200 W to 500 W.

2] Efficiency : The efficiency in electronics and electrical engineering is defined as useful power output divided by the total electrical power consumed. The efficiency of SMPS is 70 - 85%.

3] Regulation : The ability of an SMPS to maintain an output voltage within specified limits under varying input voltages and output loads.

4] Ripple : It is also sometimes called as "noise". The power supply of course produces DC outputs from the AC inputs.

5] Load regulation : This specification refers to the ability of the power supply to control the output voltage level as the load on the power supply increases or decreases.

6] Line regulation : The complement of load regulation, this parameter describes the ability of the power supply to control its output levels as the level of the AC input voltage varies from its minimum acceptable level to its maximum acceptable level.

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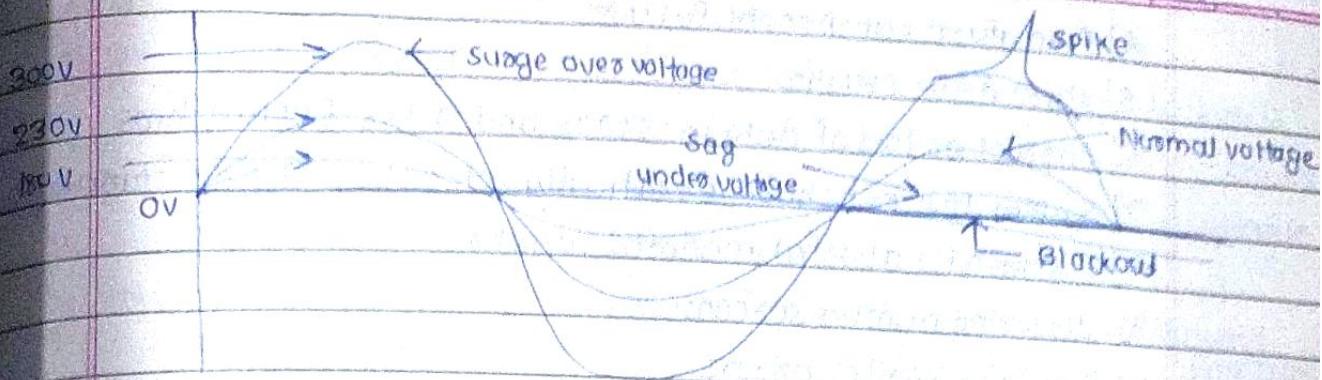
Power Problems : There are following power problems:

1] Blackouts

2] Brownouts (Sag)

3] Surge

4] Spikes



1] Blackouts : A blackout is a complete loss of electrical power where voltage and current drops almost to zero. Blackouts are usually caused by physical interruption in the power line due to accidental damage by a person or act of nature. Protection against blackout is to save work regularly.

2] Brownouts : The under voltage condition is also known as brownouts or sag. When AC voltage falls outside of a tolerable range, the power supply will fall out of regulation, resulting in intermittent system operation. Due to this, system hangs, random memory errors occur or file may be lost or corrupted on the hard drive.

3] Surge : surges are small over voltage condition that take place over relatively long period (usually more than 1 second). To regulate power to a desired level, excess energy must be switched or dissipated away.

4] Spikes :- A spike is a large over voltage condition that occurs in the millisecond. Lightning strikes and high-energy switcher can cause spikes on AC line. Heavy equipment like drill machine, grinders, welding equipments etc. can produce power spikes.

⑤ Symptoms of power problems :- The following are some :

- 1] Flickering lights
- 2] Errors in data transmission between nodes
- 3] Unexplained component lockup

- 4] Premature component failure
- 5] Hard drive crashes
- 6] Corrupt or loss of data in CMOS and other EEPROM chips
- 7] System devices behave erratically when too many are turned on
- 8] Frequently aborted modern transfers
- 9] Wavering monitor screens
- 10] Diskdrive writers errors

Most common SMPS problems: (Read from textbook) Not imp for exam.

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**Protection devices:** The protection devices are:

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1] Surge Suppressors

2] Circuit Breakers

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1] Surge Suppressors :- A surge suppressor is also called a "surge protector" is a device inserted in the alternating current utility line and/or telephone line to prevent damage to electronic equipment from voltage "spikes" called transients. A typical surge suppressor is a small box with several utility outlets, a power switch, and a 3-wire cord for plugging into a wall outlet.

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2] Circuit breakers :- A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset to resume normal operation.

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Components of circuit breaker are:

1] Actuator lever

7] Solenoid

2] Actuator mechanism

8] Arc divider / extinguisher

3] Contacts

4] Terminals

5] Bimetallic strip

6] Calibration screw

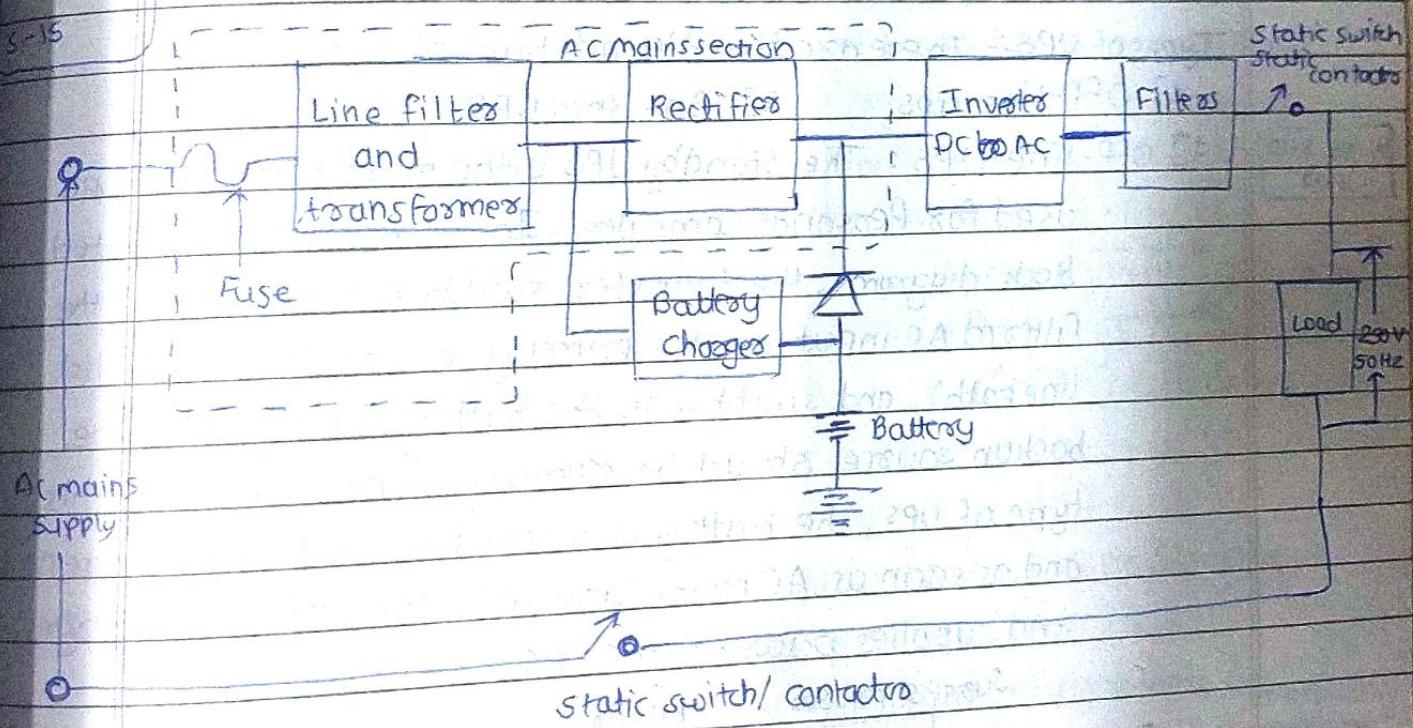
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Uninterrupted Power Supply (UPS) :- UPS is also known as uninterruptible power supply/source or a battery backup is a device which maintains a continuous supply of electric power to connected equipment by supplying power from a separate source when primary power is not available.

Need of UPS: There are some problems which are necessary to avoid using UPS:

- 1] Power failure
- 2] Voltage sag
- 3] Voltage spike
- 4] Under-voltage (Brownout)
- 5] Overvoltage
- 6] Line noise
- 7] Frequency variation
- 8] Switching Transient
- 9] Harmonic Distortion

Block diagram of UPS :



It consists of following Functional blocks:

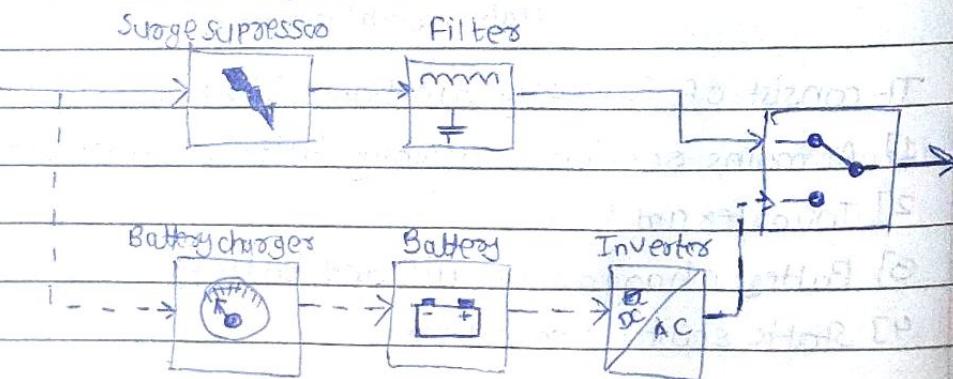
- 1] AC mains section containing filter, transformer and rectifiers
- 2] Inverter and Filter
- 3] Battery charger circuit and battery
- 4] Static switch / contactor

- 1) Ac mains section :- An AC mains section receives AC supply. It filters it with the help of line filters and rectifies it to desired level for further circuits.
- 2) Inverter & filter :- When power is lost or off, this section takes 12V DC from battery, to convert it into 230V, 50Hz with the help of inverter and given to the output load.
- 3) Battery and battery charger :- When AC supply is available, this section charges the battery through the desired DC levels and charges the battery.
- 4) static switch / contactor :- In the event of power failure, the inverter connected to the load with the help of static contactor switches.

Types of UPS :- There are two distinct type of UPS

- 1] Off-line UPS
- 2] On-line UPS

1] OFF-line UPS : The Standby UPS is the most common type used for Personal Computer. In the below illustrated block diagram, the transfer switch is set to choose the filtered AC input as the primary power source (solid line path), and switches to the battery / inverter as the backup source should be primary source fail. In this type of UPS, the battery is charged when AC mains are on and as soon as AC mains goes off, the battery discharges and supplies power to the PC.



OFF-line UPS

### Advantages:

- 1) Lowered in cost as compared to on-line UPS.

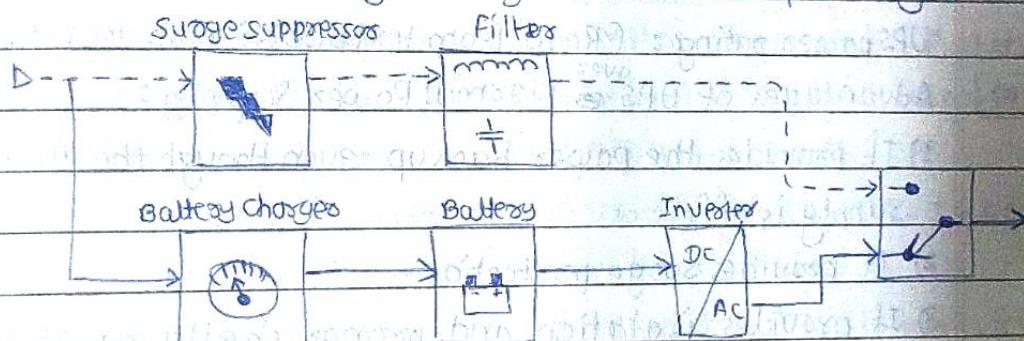
### Disadvantages:

- 1) High switching is required otherwise there is a possibility that cut in power and reboot the system.

2] On-line UPS : The online UPS is sometimes called true UPS. The

online type of UPS, in addition to providing against complete failure of the utility supply, provides protection against all common power problems, and for this reason it is also known as a power conditioner and a line conditioner.

In on-line UPS, the power from the system is supplied by batteries continuously i.e. battery charge continuously. The battery provides DC voltage to the inverter converts DC to 230V, 50Hz AC voltage and gives to the computer system.



ONline UPS

### Advantages:

- 1) The switching is not involved, thus avoid resetting of PC & spike generation.

- 2) The computer is effectively isolated from AC line problems.
- 3) These UPS provides large protection by breaking down and cutting the power.

### Disadvantages:

- 1) It is costlier than off-line UPS.
- 2) It generates more heat.
- 3) UPS batteries require more frequent replacement since they run constantly.
- 4) The UPS runs its inverter all the time results in a low UPS efficiency.

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### Comparison of Online & offline UPS :-

#### Online UPS

- 1) Online UPS are complex and expensive.
- 2) The battery is continuously charged and then delivers DC power to inverter for converting to AC and supplying to the PC.
- 3) Switching is not involved.
- 4) It is at high speed so as to avoid resetting of PC therefore resetting may occur some time.
- 5) Spikes are not generated.

#### Offline UPS

- 1) Offline UPS are the simplest and least expensive.
- 2) Battery is charged when AC mains are on and as soon as AC mains are off, battery discharges and supplies power to the PC.
- 3) Switching is involved.
- 4) It is not at high speed, therefore resetting may occur some time.
- 5) Spikes are generated.

UPS power rating : (Read from textbook) Not imp for exam.

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### Advantages of UPS over Normal Power Supply :

- 1) It provides the power backup even though the AC mains power supply is off.
- 2) It provides surge protection.
- 3) It provides isolation and proper shielding of power.
- 4) It provides short circuit protection.
- 5) It stabilizes the power.
- 6) It maintains constant 230V 50Hz frequency.
- 7) It provides power conditioning.
- 8) Allow you enough time to save whatever you are doing.
- 9) It avoids data loss.
- 10) It provides operating system software from corruption or loss.
- 11) It can be controlled by operating system and thus called as smart UPS.