Medical instrumentation System

Second stage

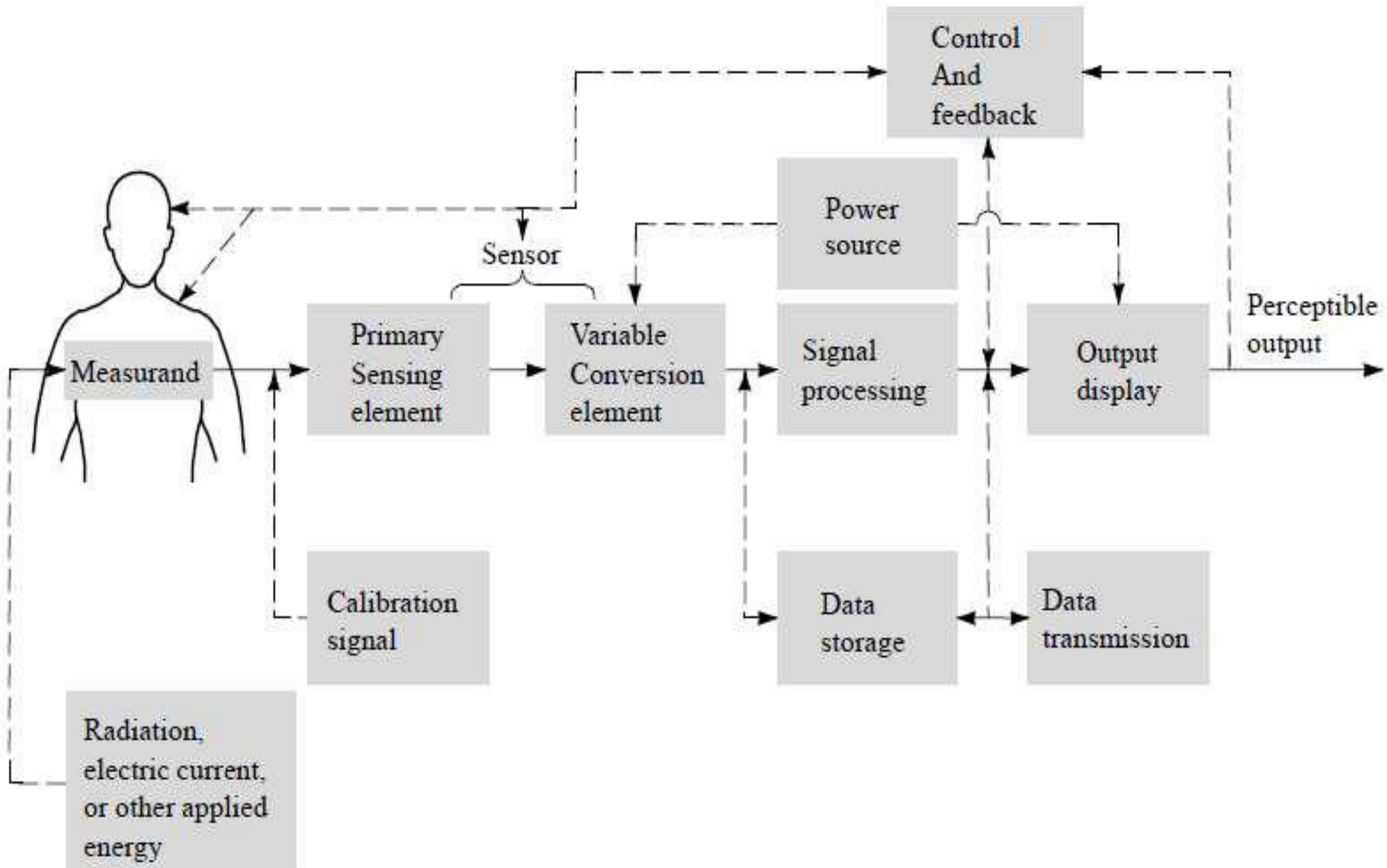
Lecture

Assistant Lecturer

Mohammed S. Hamzah

A Laboratory Medical Instrumentation System

- is designed for use in clinical and research labs, aimed at collecting, processing, and analyzing biological or physiological data from samples or patients. These systems are vital for diagnostic purposes, research, and treatment planning in medical laboratories


Control
And
feedback
Power
source
Sensor
Perceptible
output
Measurand
Primary
Sensing
element
Variable
Conversion
element
Signal
processing
Output
display
Calibration
signal
Data
storage
Data
transmission
Radiation,
electric current,
or other applied
energy

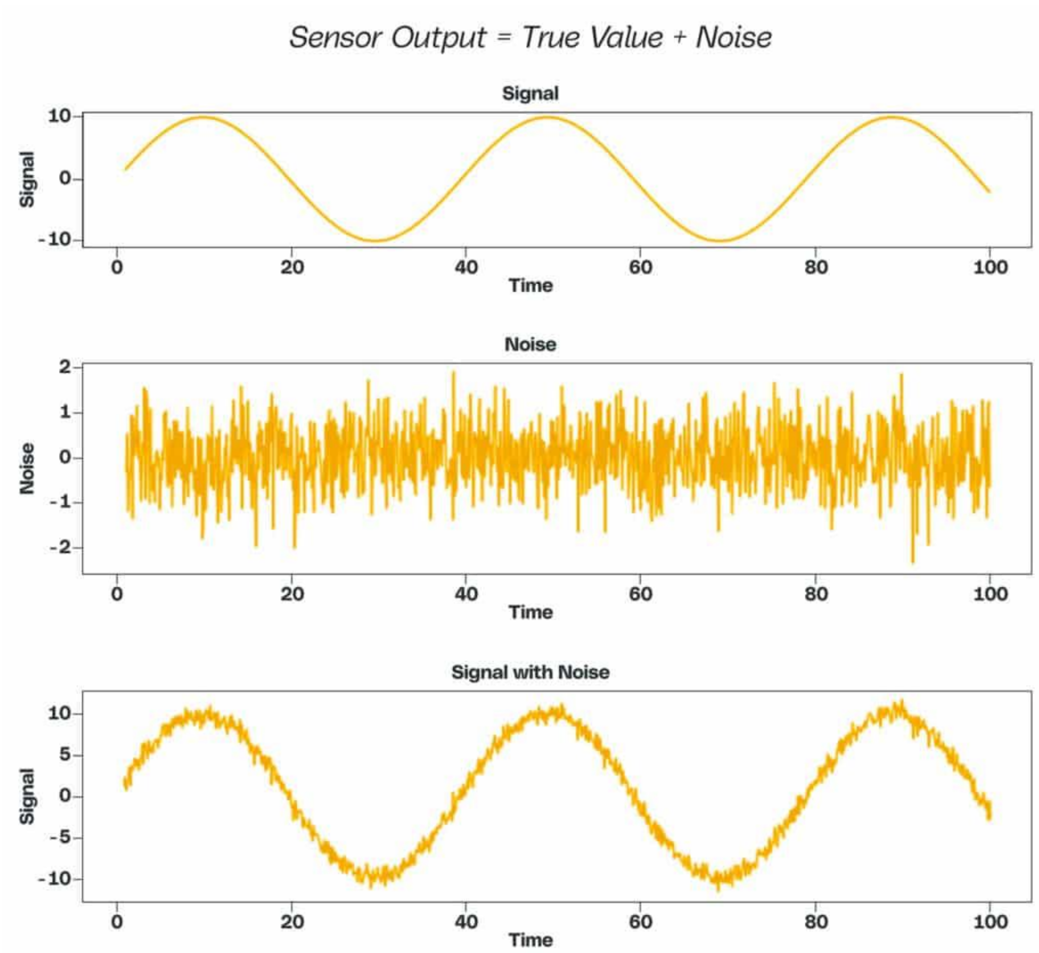
Key Components of a Generalized Laboratory Medical Instrumentation System

- **Biological or Physiological Sample Source**
  - **Input Source**: This could be biological tissues, fluids (e.g., blood, urine), or physiological signals (e.g., ECG signals, brain activity).
  - Samples or physiological data are collected for analysis.

- **Sensors/Transducers**
- Sensors convert the biological signals into measurable electrical signals or other forms of data for processing.
- Example sensors:
  - **Biochemical Sensors**: Detect specific chemical reactions in blood or urine samples.
  - **Electrodes**: Used for electrophysiological studies such as ECG or EEG.


Color Sensor
Touch Sensor
Ultrasonic Sensor
Alcohol Sensor
Humidity Sensor
Air Pressure Sensor
Gyro + Accelero Sensor
Hall Effect Sensor
Soil Sensor
Proximity Sensor
Heartbeat Sensor
Infrared Sensor
IR Receiver
Temp. Sensor
Light Sensors
Load Sensor
Pulse Oximeter
Gas Sensor
Flow Sensor
Opto Speed Sensor
PIR Motion Sensor
Rain Sensor
Tilt Sensor
Sound Sensor

- **Signal Conditioning**
- **Amplification**: In cases where signals are weak, amplification ensures they are strong enough for measurement.
- **Filtering**: Removes noise and irrelevant data. For example, filtering high-frequency noise in ECG signals.
- **Analog-to-Digital Conversion (ADC)**: Converts analog signals from sensors to digital signals for further computational processing.



Sensor Output = True Value + Noise
Signal
Signal
10
0
-10
0
20
40
60
80
100
Time
Noise
Noise
2
1
0
-1
-2
0
20
40
60
80
100
Time
Signal with Noise
Signal
10
5
0
-5
-10
0
20
40
60
80
100
Time

Data Processing & Analysis

- Data is processed using algorithms for signal processing, pattern recognition, or statistical analysis.
- In laboratories, systems often use advanced software tools for data manipulation, trend analysis, or real-time monitoring.
- Example applications:
  - **Spectral Analysis**: For signals like EEG, analyzing the frequency components is essential.
  - **Biochemical Assays**: For detecting concentrations of certain molecules in a blood sample.

Output Display & Storage

- **Visualization**: Results are often shown in real-time graphs or tabular formats, giving laboratory professionals a visual understanding of the data.
- **Storage**: Results can be stored in laboratory information management systems (LIMS) for future analysis or reporting.
- **Integration**: Modern systems often integrate with hospital databases and electronic medical records (EMRs).

- **Control System**
  - A control system may be used to automate functions such as sample handling, environmental control (temperature, humidity), or adjustments based on real-time feedback.
  - **Automation**: Many lab systems are automated for efficiency and accuracy, especially in high-throughput labs.

Auxiliary Elements in Laboratory Medical Instrumentation Systems

1. **Power Supply**
   - Provides stable power, ensuring the continuous operation of lab instruments, especially those running long tests or requiring real-time monitoring.
   - Backup systems are essential to avoid data loss or interruptions.
2. **Calibration Systems**
   - Calibration is critical in labs for ensuring that readings are accurate and consistent over time. Automated or manual calibration procedures are used.
   - Instruments are regularly calibrated using standard references (e.g., known concentrations in biochemical assays).

3. **Environmental Control**

- Systems must control for environmental conditions like temperature, humidity, and light, especially when dealing with sensitive samples or equipment like microscopes and biochemical analyzers.

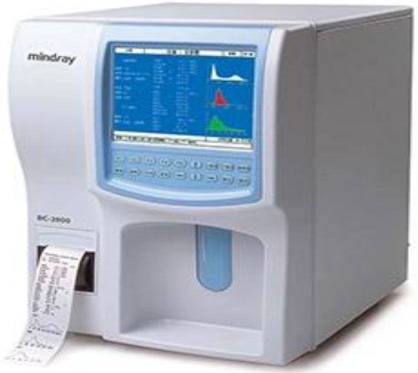
4. **Communication Interfaces**

- Systems need interfaces for communicating with other lab instruments, databases, and hospital networks.
- Communication protocols ensure data transfer security and integrity, particularly in sensitive clinical or research environments.

5. **Safety Systems**
   - Safety mechanisms ensure that samples are handled properly, hazardous chemicals are managed, and sensitive data is protected.
   - Error detection systems prevent false readings or system malfunctions.
6. **User Interfaces**
   – Interfaces allow laboratory personnel to operate the system effectively. Graphical user interfaces (GUIs) are often used for intuitive operation and configuration.
   – Modern systems might include touchscreens or remote access capabilities for real-time adjustments.

Examples of Generalized Laboratory Medical Instruments

- **Automated Biochemistry Analyzers**
  - Used for measuring the concentration of substances (e.g., glucose, electrolytes) in biological samples like blood or urine.
  - These devices combine sample preparation, processing, and data analysis into one system, providing results quickly and accurately.
- **Electrophysiology Systems**
  - Designed for recording electrical signals from cells, tissues, or organs. For example, EEG systems for brainwave recording.
  - These systems integrate data acquisition, signal processing, and storage, with advanced data analysis options for real-time monitoring.



Hematology Analyzer

Biochemistry Analyzer

Electrolyte Analyzer

Elisa Reader

- **Flow Cytometers**
  - Used for analyzing the physical and chemical characteristics of cells or particles in a fluid as they pass through a laser beam.
  - Flow cytometers use detectors to measure cell properties, process the data, and display results graphically.

Real-Time and Delayed-Time Modes in Lab Medicine Instruments

1. Real-Time Mode

- **Definition**: Provides immediate results.
- **Examples**: Point-of-care devices (glucose meters, rapid antigen tests), real-time PCR, continuous glucose monitors.
- **Applications**: Emergency care, ICU, urgent medical decisions.
- **Characteristics**: Fast results (seconds/minutes), direct clinical impact

2. Delayed-Time Mode

- **Definition**: Results are delivered after a delay (hours/days).
- **Examples**: Laboratory-based tests (blood panels, cultures), batch processing, delayed PCR.
- **Applications**: Routine diagnostics, complex tests, high-throughput labs.
- **Characteristics**: Slower results, less immediate clinical relevance.
- **Comparison:**
- **Real-Time**: Fast, used for critical care.
- **Delayed-Time**: Slower, used for routine or complex diagnostics.

THANKS FOR LISTING

Medical instrumentation System

Second stage

Lecture Hot Dry Oven

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Hot Dry Oven Definition

- A hot air oven is a type of dry heat sterilization consider laboratory instrument that uses dry heat to sterilize laboratory equipment and other materials.
- Dry heat sterilization is used on equipment that cannot be wet and on material that will not melt, catch fire, or change form when exposed to high temperatures. Moist heat sterilization uses water to boil items or steam them to sterilize and doesn't take as long as dry heat sterilization. Examples of items that aren't sterilized in a hot air oven are surgical dressings, rubber items, or plastic material. Items that are sterilized in a hot air oven include:
- Glassware (like petri dishes, flasks, pipettes, and test tubes)
- Powders (like starch, zinc oxide, and sulfadiazine)
- Materials that contain oils
- Metal equipment (like scalpels, scissors, and blades).

- Hot air ovens use extremely high temperatures over several hours to destroy microorganisms and bacterial spores. The ovens use conduction to sterilize items by heating the outside surfaces of the item, which then absorbs the heat and moves it towards the center of the item. The commonly-used temperatures and time that hot air ovens need to sterilize materials is 170 degrees Celsius for 30 minutes, 160 degrees Celsius for 60 minutes, and 150 degrees Celsius for 150 minutes.

Types of Medical Ovens

1. **Dry Heat Sterilizers**: Used for sterilizing medical tools through high temperatures. Dry heat sterilization destroys microbial life, including spores.
2. **Incubators**: Maintain stable temperatures for culturing cells and microorganisms, often used in research and clinical labs.
3. **Vacuum Ovens**: Ideal for delicate drying processes. They reduce atmospheric pressure, lowering the boiling points of liquids and allowing gentle drying of materials that may be heat-sensitive.

Hot Air Oven Examples

EG SeriesHot Air Drying Oven
(Steelco SpA)

Forced Air Oven FAC-100
(Tech-Lab Scientific)

Sterilization Oven FN 120
(Nüve)

Heating oven WHL-25
(Tianjin Taisite)

Heating Oven 101A / 202A series
(Zhejiang FUXIA Equipment)

The parts of oven:

1. Mechanical part.
2. Electrical part.

Mechanical part:

1. The Coat (outer shield).
2. Fiber glass.
3. The chamber.
4. The shelves (mesh).

1. The coat:

The coat is made of aluminum or stainless steel because it is characterized by the following:

a) Resisting the mechanical shocks

b) Resisting the oxidation.

c) Rectangular solid shape to be easily placed anywhere in the laboratory.

d) The coat consists of several surfaces an isolator material prevents heat from getting outside.

2. Fiber glass:

There are two types of fiber glass:

a) Brown fiber glass: be somewhat cheap, but it is a dangerous substance because it causes inflammation in the chest should be wary of dealing with. often identified as cellulose **insulation**, is primarily made from recycled paper products. This includes newspaper, cardboard, and other forms

b) Yellow fiber glass: less dangerous than brown, because the sensitivity and cause him to be careful to wear gloves. The advantage of fiberglass good insulator of heat and use it in your device due to lack of access of heat from inside the device to the outside and maintain the internal temperature . The color is provided by the resin-based binder that helps to hold the spun glass fibers together.

3. The chamber:

The chamber is completely made of aluminum or stainless steel because it has the following characteristics:

a) Rectangular solid shape to suit dealing with various objects.

b) It has thermally insulated from all other parts of the oven to prevent effective on them.

c) It has ribs to put shelves in the wanted levels.

d) It is made from materials characterized by oxidations' resisting.

4. The shelves

(mesh): they are plates on which the objects are placed, the number of shelves is varying according to the number and size of objects, the oven capacity. It characterized by:

a) They are made of aluminum which is considered as oxidation resisting material.

b) When they are placed in their locations on the ribs some area is lifted to allow movement of air, some shelves contain openings to help this purpose.

2. Electric part:

1. The power supply.
2. The heater.
3. Thermostat.
4. Temperature indicator (thermometer).
5. Timer.
6. Fuses.
7. Control panel.

1. Power supply:

1. Power supply: The used supply in dry sterilized device is 220v — 50Hz the step down transformer and rectifying circuit (AC to DC convert) To run the control panel if the parameters, numeric or other departments in the modern fashion.

2. The Heater:

The electric heating system is the system in which

heating produce by rising of temperature caused by the passing of electric current. through a conductor having a high resistor to current flow, it is only placed in base of the instrument.

The heater is an ingot of iron and carbon coated by two layers: the inner layer of **ceramic material** and outer layer of metal usually the same as the inner heater.

The heater element has the following characteristics:

1- High resistance

2- Electrical insulation.

3- Thermal conductivity.

- There are 6 types of heaters used in dry oven,
  1- One side circular type heater.
  2- One side U type heater.
  3- One side wave type heater
  4- One side square type heater
  5- Three sides type heater.
  6- Four sides type heater.

3. Thermostat

A thermistor is a type of temperature-sensitive semiconductor, often made from ceramic materials, and is characterized by having a negative temperature coefficient (NTC). This means its resistance decreases as the temperature increases, which is a key feature in its operation as a temperature sensor.

In contrast, a **thermostat** is a broader term for a device that regulates temperature by switching a system on or off based on preset temperature levels, and it often uses thermistors or other sensors to measure temperature.

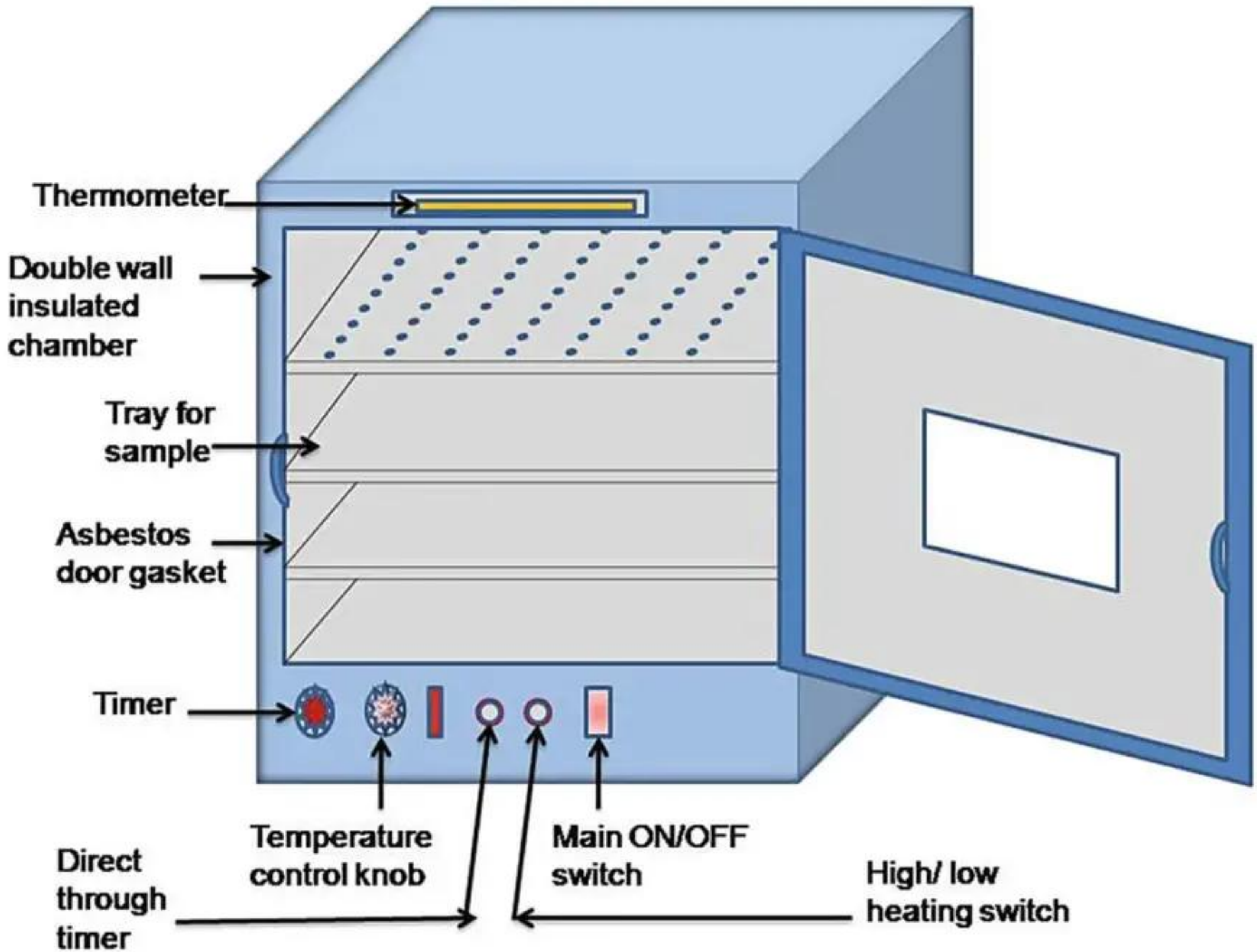
4. Temperature indicator

4. Temperature indicator: Tows way are used in temperature indicator there are thermometer and thermocouple & Identified for the internal temperature.

5. Timer: There are two type of timer electrical or mechanical at range 60 min given period of time required for sterilization.

6. Fuse: To protect the circuit from high current, high loads, short circuits..

7. Control panel: (oven door) contains several elements and the most important about indicator power lamp usually green & indicator heater lamp usually red & contain switch on-off and timer & knob.


Thermometer
Double wall insulated chamber
Tray for sample
Asbestos door gasket
Timer
Temperature control knob
Main ON/OFF switch
Direct through timer
High/ low heating switch

Applications

Sterilization: Medical instruments, syringes, surgical tools.

Laboratory Work: For drying or dehydrating samples, chemicals, or biological specimens.

Pharmaceuticals: Production of drugs where controlled heat treatments are essential.

Choosing the Right Oven

Capacity: Small labs may require compact designs, whereas larger facilities need more spacious ovens.

Temperature Range: Select based on specific lab processes (incubation vs. high-temperature sterilization).

Energy Efficiency: Modern ovens offer energy-saving features, reducing operational costs.

Maintenance and Safety

- Regular calibration ensures precise temperature control.
- Cleaning prevents contamination, critical in medical environments.
- Always follow manufacturer guidelines for safe usage, including the handling of hot materials and correct load placement

Hot Air Oven Advantages

- No need to water to sterilize the material.
- Not much pressure is created like autoclave which creates it easy to manage and also makes it safer to work with.
- In a laboratory environment, it is more fitting to use as compared to other sterilizers.
- Hot air oven is much smaller in size as compared to autoclaves and also more effective.
- A hot air oven can be more speed than an autoclave and higher temperature can be achieved as compared to other means.
- The operating procedure is simple as compared to other sterilization methods
- Its price is low as compared to autoclave.

Hot Air Oven Disadvantages

- According to the principle of thermal inactivation by oxidation, it cannot slaughter some living organisms, such as prions due to the use of dry heat rather than wet heat.
- Most of the materials are not fit with hot air ovens such as surgical dressings, rubber items, or plastic material; they can be a meltdown at low temperatures.

Medical instrumentation System

Second stage

Autoclave

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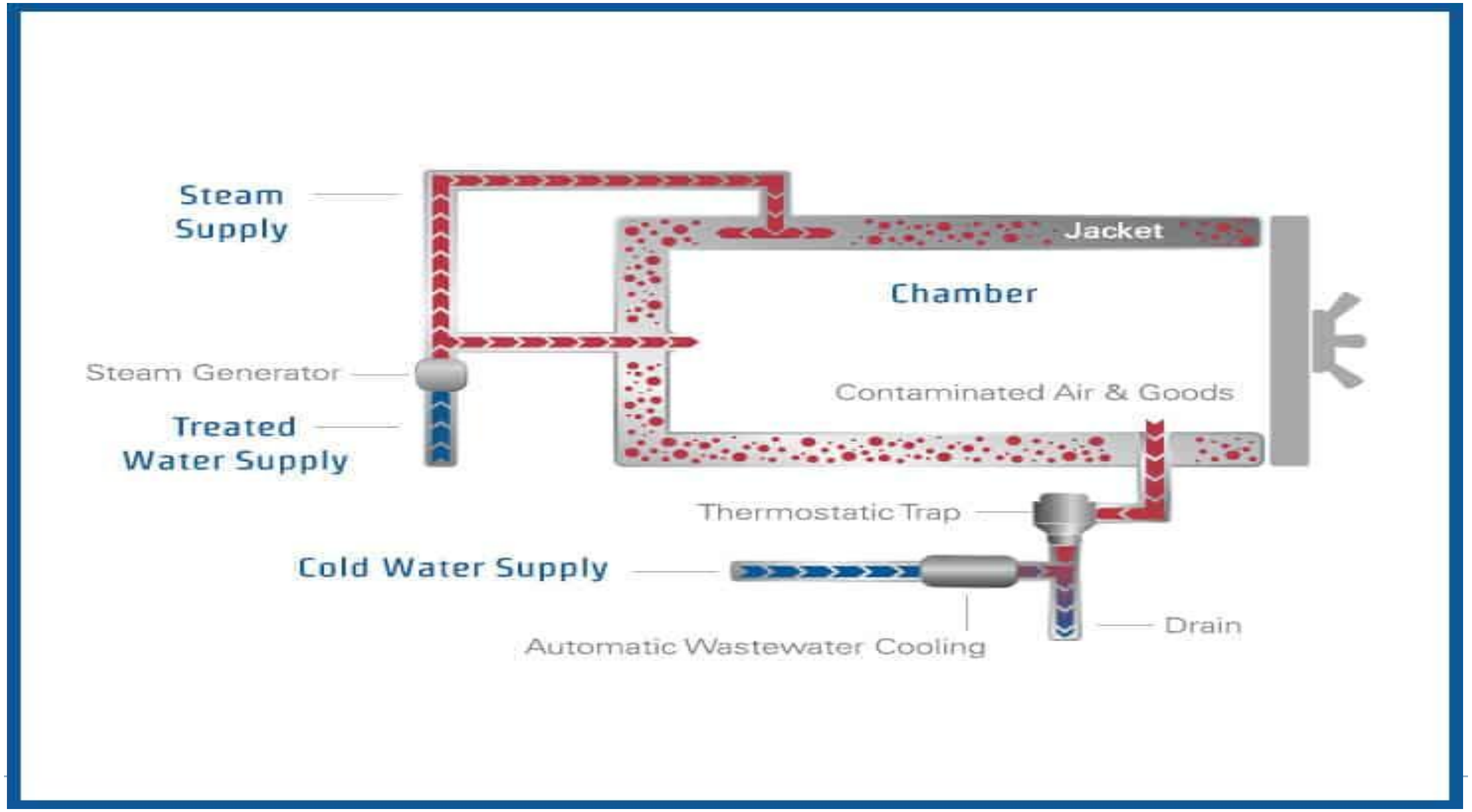
What is an Autoclave?

- **Overview**: An autoclave is a device designed to achieve sterilization through the use of high-pressure steam. Sterilization is the process of eliminating all forms of microbial life, including bacteria, viruses, fungi, and their spores. This is particularly important in environments where the presence of microorganisms could lead to contamination, infection, or compromised experimental results.

Sterilization vs. Disinfection

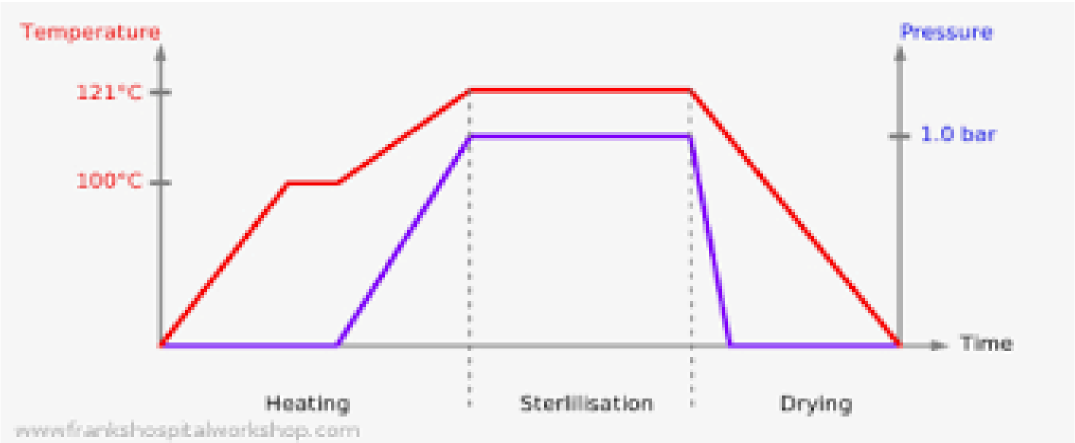
- Sterilization is more rigorous than disinfection, which only reduces the number of microorganisms to a safe level rather than completely destroying them.



Basic Principle: Steam Sterilization:

- **Steam Under Pressure**: Water boils at 100°C (212°F) under normal atmospheric pressure. In an autoclave, steam is used in a pressurized chamber, allowing the steam to reach much higher temperatures (typically 121°C or 134°C) without boiling.
- **Why Pressure is Important**: Simply boiling water or exposing items to steam at 100°C is not enough to kill all pathogens, especially heat-resistant spores like those from *Bacillus* and *Clostridium* species. By increasing the pressure inside the autoclave, we raise the boiling point of water, allowing for higher sterilizing temperatures.

- **Moist Heat**: Steam is more effective than dry heat because moisture transfers heat more efficiently, allowing it to penetrate deeper into materials. This ensures that even porous or tightly packed materials can be sterilized effectively.



Autoclave Cycles:

- **Gravity Displacement**: Steam is introduced into the chamber, and air, being lighter, is forced out of the bottom. This process relies on gravity to remove air and allow the steam to fill the chamber.
- **Pre-Vacuum Cycle (High-Speed)**: In this method, air is evacuated from the chamber via a vacuum pump before steam is introduced. This allows steam to quickly and evenly penetrate even complex or porous materials, making the process more efficient and ensuring no air pockets remain.
- **Drying**: After sterilization, most autoclaves include a drying cycle, where the steam is vented, and a vacuum may be applied to remove moisture from the items.

Types of Autoclaves

1- Gravity Displacement Autoclave:

- **How It Works**: In a gravity displacement autoclave, steam is pumped into the chamber and displaces air by forcing it out through a vent at the bottom. Once the air is displaced, steam comes into direct contact with the materials inside.
- **Applications**: This type is used for sterilizing solid instruments, glassware, and unwrapped items. It is slower and less efficient than vacuum autoclaves for certain applications but works well for basic sterilization needs.
- **Limitations**: It's less effective for porous loads (textiles, wrapped instruments) because air can remain trapped in the load, impeding proper steam penetration

2-Pre-Vacuum (or High-Speed) Autoclave:

- **How It Works**: The pre-vacuum autoclave removes air from the chamber before introducing steam. This ensures that the steam can fully penetrate the materials without any air pockets.
- **Applications**: These are used for sterilizing porous materials, such as surgical gowns, instruments wrapped in pouches, and complex machinery. The vacuum cycle allows for quicker and more complete sterilization.
- **Advantages**: More efficient in terms of both time and effectiveness, particularly for larger or more complex loads.

3-Benchtop Autoclaves:

- **How It Works**: These are compact, self-contained units used in small-scale operations such as dental clinics, veterinary clinics, and tattoo parlors.
- **Applications**: Suitable for smaller instruments and loads that need frequent sterilization but not large quantities.

4- Industrial Autoclaves:

- **How It Works**: Larger, industrial-grade autoclaves are used for large-scale sterilization processes, such as in the pharmaceutical or food industries.
- **Applications**: Sterilization of medical devices, food packaging, and production equipment.

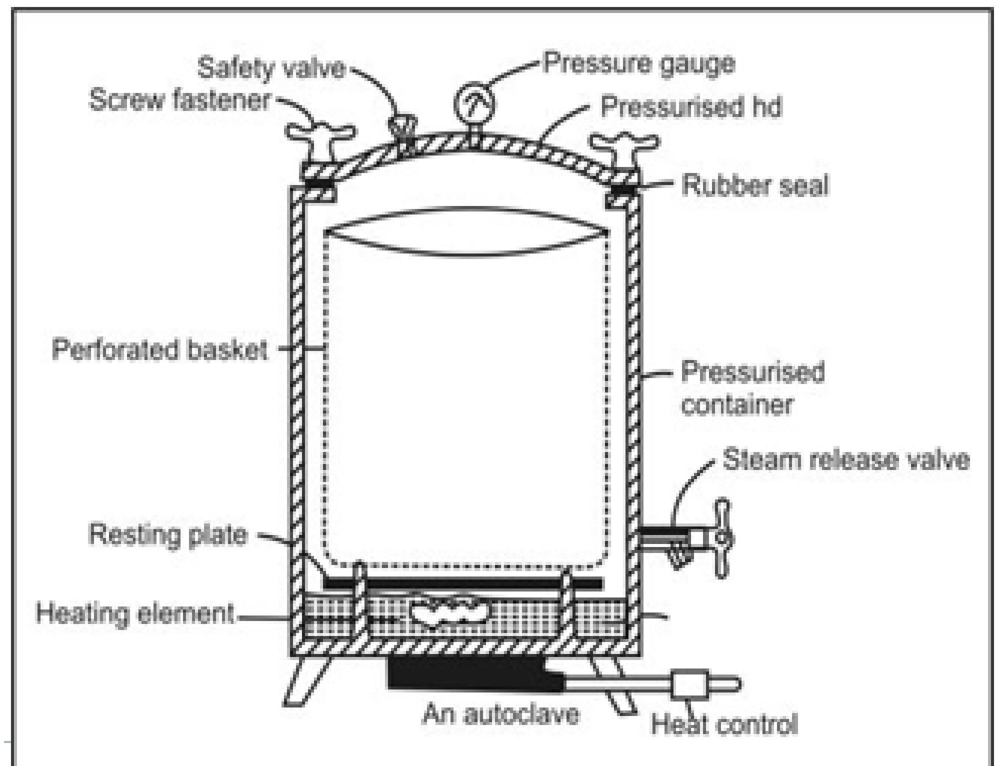
Components of an Autoclave

- **Chamber**:
  - The heart of the autoclave. It is a robust, sealed container where the sterilization process takes place. Chambers are typically made of stainless steel to resist corrosion and withstand high pressure and temperatures.
- **Steam Generator**:
  - Produces the high-pressure steam needed for sterilization. In some autoclaves, this is part of the machine, while others rely on external steam sources.
  - Autoclaves don't have personalities, but the autoclave steam generator can be positioned either under the autoclave, this is called a built-in steam generator, or it can be external to the autoclave, an independent standalone steam generato

- **Pressure and Temperature Gauges**: These gauges monitor the pressure and temperature inside the autoclave to ensure proper sterilization conditions. The temperature must reach at least 121°C (for standard sterilization) or 134°C (for more rapid cycles), and the pressure is usually set to 15 PSI.
- **Safety Valve**: Prevents overpressure inside the chamber by releasing steam if the pressure becomes too high. This ensures the system operates within safe limits.
- **Door with Locking Mechanism**: The door must be able to withstand high pressure and remain sealed throughout the cycle. Modern autoclaves have interlocks that prevent the door from opening until the pressure inside the chamber has returned to normal.

Control Panel:

- Allows the user to program the sterilization cycle, monitor progress, and ensure the correct conditions are maintained.



The Sterilization Process – Step-by-Step

- **Preparation**:
  - Materials must be cleaned before autoclaving to remove organic matter. Instruments are typically placed in stainless steel trays or wrapped in sterilization pouches.
- **Loading**:
  - Items are loaded into the chamber in such a way that steam can circulate freely around them. Careful arrangement is crucial, as overcrowding can result in incomplete sterilization.
- **Air Removal**:
  - For gravity displacement autoclaves, steam enters the chamber and pushes the air out. In pre-vacuum autoclaves, a vacuum pump removes the air first to ensure better steam penetration.

- **Sterilization (Exposure) Phase**:
  - The steam temperature rises to the desired level (usually 121°C at 15 PSI), and the materials are held at this temperature for a set time (typically 15-20 minutes). The heat and moisture denature the proteins of microorganisms, killing them and rendering them inactive.
- **Exhaust and Drying**:
  - After the exposure phase, steam is released, and the pressure inside the chamber is returned to atmospheric levels. A drying cycle is often used to remove moisture from sterilized items, especially if the materials are porous.
- **Unloading**:
  - Once the cycle is complete and the temperature has decreased, items can be safely removed. Caution must be taken to avoid burns from the hot materials.

Applications of Autoclaves

- **Medical and Healthcare**:
  - **Surgical Instruments**: Autoclaves are used to sterilize scalpels, forceps, clamps, and other surgical tools. These tools must be completely sterile to prevent infections during surgeries.
  - **Textiles**: Surgical gowns, drapes, and masks must also be sterilized, especially for use in sterile operating rooms.
  - **Glassware and Lab Tools**: Autoclaves are used in hospitals to sterilize reusable glass syringes, petri dishes, and lab instruments.

- **Laboratories**:
  - **Culture Media**: Before conducting microbial growth experiments, culture media are sterilized to eliminate any pre-existing microorganisms.
  - **Laboratory Waste**: Infectious waste generated from biological research is sterilized in autoclaves before being safely disposed of.
- **Pharmaceutical and Food Industry**:
  - **Pharmaceutical Products**: Autoclaves are used to sterilize vials, containers, and instruments in drug production to prevent contamination.
  - **Food Packaging**: In canning, autoclaves ensure that food products are free from harmful microorganisms before sealing.

Safety Measures and Precautions

- **Proper Training**:
  - Only trained personnel should operate autoclaves to avoid accidents caused by improper loading, unloading, or incorrect sterilization cycles.
- **Personal Protective Equipment (PPE)**:
  - Operators must wear heat-resistant gloves, protective clothing, and face shields when handling hot items after sterilization.
- **Routine Maintenance**:
  - Regular inspection and maintenance of pressure valves, gaskets, and temperature sensors are critical for safe operation. Any worn or damaged parts must be replaced immediately.
- **Loading and Unloading Procedures**:
  - Items should not be packed too tightly to ensure adequate steam penetration. After a cycle, wait for the chamber to depressurize fully before opening the door.

Advantages of Autoclaves

- **Complete Sterilization**: Autoclaves can kill even the most resistant spores, making them more reliable than chemical disinfectants.
- **Environmentally Friendly**: Autoclaves use only water and heat for sterilization, producing no harmful by-products.
- **Versatility**: They can sterilize a wide range of materials, from surgical instruments to culture media and biological waste.

Limitations of Autoclaves

- **Not Suitable for Heat-Sensitive Items**: Autoclaving can damage plastics, electronics, or heat-sensitive drugs.
- **Size Limitations**: Larger instruments or complex equipment may require industrial autoclaves, which are expensive and occupy significant space.
- **Operational Complexity**: Operators must be trained to ensure correct use. Improper loading or incorrect cycle settings can lead to incomplete sterilization.

Medical instrumentation System

Second stage

Lecture Electronic balance

Assistant Lecturer

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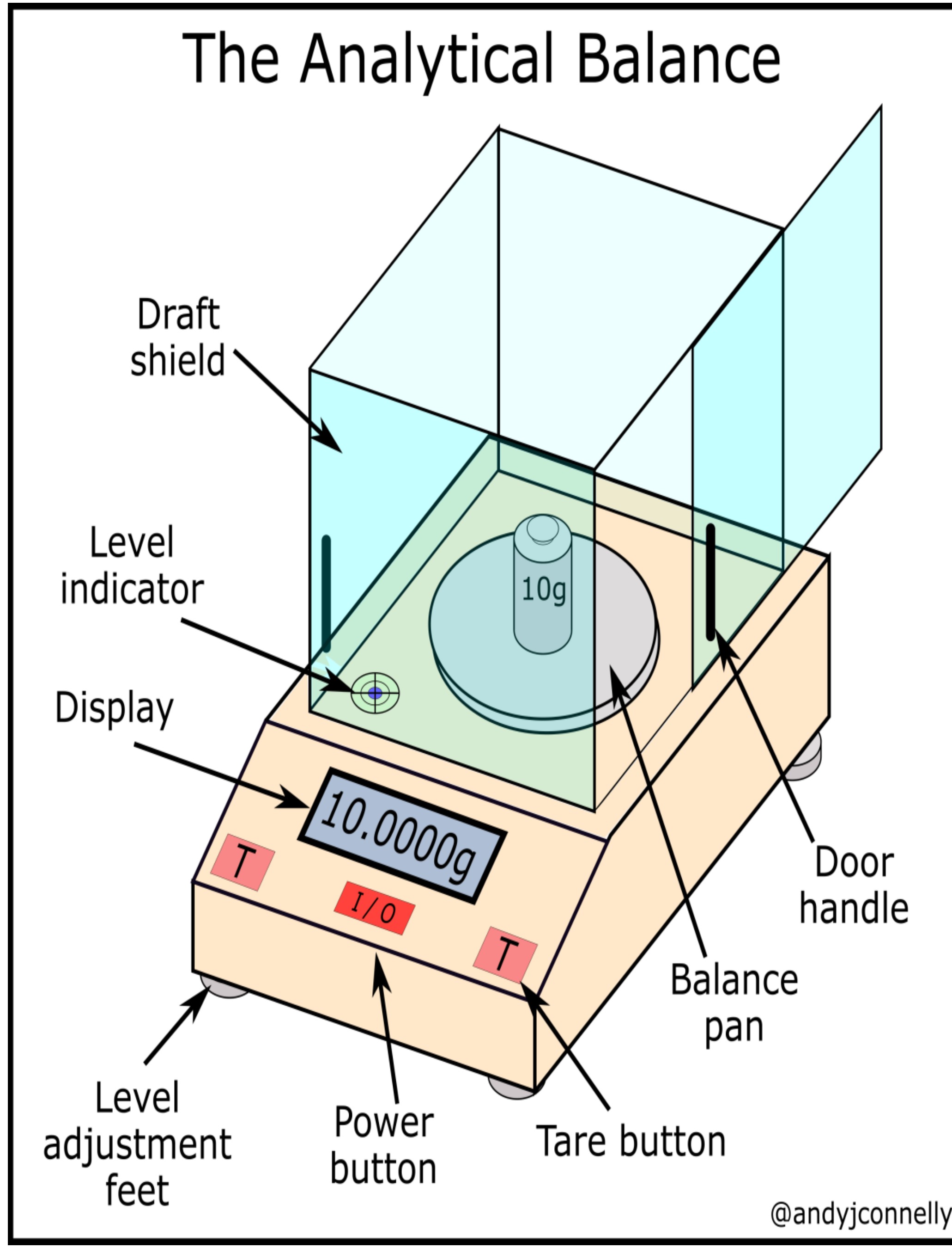
Electronic balance

- It's a medical instrument used for measuring of weight, the weight wanted to be measured in laboratories are usually chemicals and sometimes be specimens. The unit used in all balances is the metric units: this meaning that balances uses grams, milligrams, micrograms, kilograms.
- All Balances can be grouped with in two categories, they are:
- Rom balances: with accuracy of 0.01g or greater they are either full mechanical or electromechanical systems.
- Analytical balances: with accuracy of 0.001g or less, mechanically or electromechanical systems.

Components:

1. Pan: on which the weight to be measured is placed.
2. Beam: a leaver supported by a knife plane edge in the center point.
3. Movable weights: Placed inside the balance& sometimes inside and outside the balance are attached to the beam to bring the balance to equilibrium.
4. Reading scale: mechanical, optical or digital reading scale. In optical scale a light bulb, mirrors, microfilm& power supply must be found. In digital scale analogue to digital converter, power supply& 7 segments display must be found.
5. Position net: small piece of screwed weight fixed at the bottom of pan, used for setting zero.


The Analytical Balance
Draft shield
Level indicator
Display
10.0000g
10g
T
I/O
T
Door handle
Balance pan
Level adjustment feet
Power button
Tare button
@andyjconnelly

How Electronic Balances Work

The quickest way to understand the principle of how electronic balances work is to first understand how they are constructed. There are two basic types of electronic balance designs.

1. Electromagnetic balancing type
2. Electrical resistance wire type (load cell type)

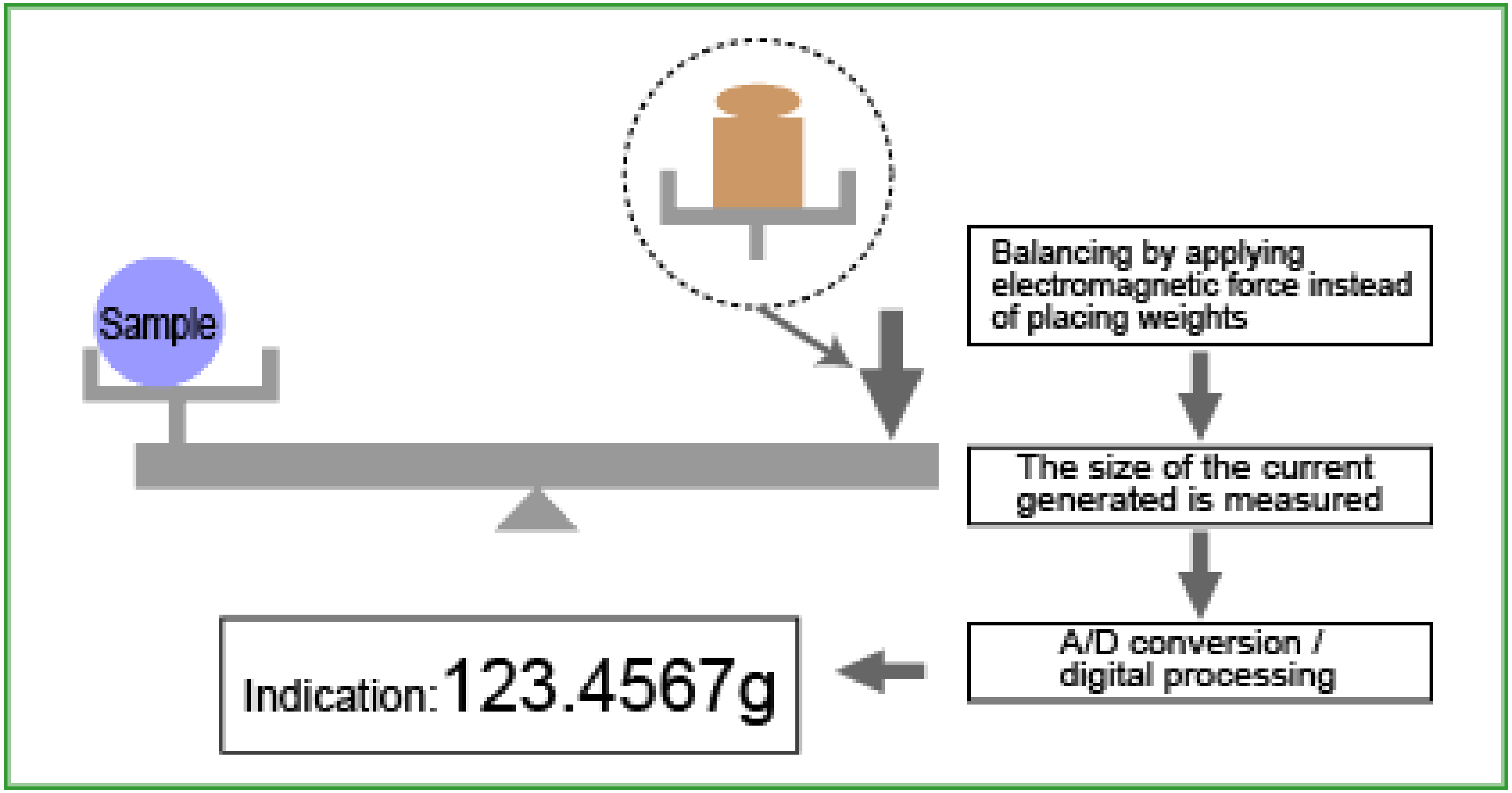
These are based on completely different principles, but what they both have in common is that **neither directly measures mass**. They **measure the force** that acts downward on the pan. This force is converted to an electrical signal and displayed on a digital

- As a means of measuring force, the electromagnetic balance method utilizes the electromagnetic force generated from a magnet and coil,
- whereas the electrical resistance wire method utilizes the change in resistance value of a strain gauge attached to a piece of metal that bends in response to a force. So why do electronic balances display mass values when that is not what they measure? It is because the reference standards for mass are weights, which are placed on a pan to inform the electronic balance that a given force is equivalent to a given number of grams, which is used for conversion. Consequently, electronic balances that do not perform this conversion accurately cannot display accurate mass values.

- electronic balance that a given force is equivalent to a given number of grams, which is used for conversion. Consequently, electronic balances that do not perform this conversion accurately cannot display accurate mass values
- **Electromagnetic Type and Load Cell Type**
- Various principles are used for measuring the weight of objects. The following briefly describes the operating principles and features of the two most popular methods, "electromagnetic type" and "load cell type."

Electromagnetic Type

- This is also called the "electromagnetic balance method." With mechanical balances, the sample is placed at one end of the beam and the weight is placed at the other end, and the value of the weight when both are perfectly balanced becomes the mass of the sample. With electromagnetic type balances, an electrical force (electromagnetic force) is applied instead of a placed weight to balance the beam. The amount of electricity required for balancing the beam changes according to the weight of the sample that is placed. The amount of current when the beam is perfectly balanced is detected, and the mass is obtained from that detected value, see figure (2).



- Fig(2):Show how the electromagnetic Type of electronic balance work.

- **Load Cell Type (electrical resistance wire method)**
- One end of an object (elastic body) made of aluminum and shaped as shown in the figure is fixed in place, and the sample is placed on the other end. The weight of the sample causes the elastic body to flex. The amount of flex causes the strain gauges attached to the elastic body to expand and contract, changing the amount of electricity that is output (strictly speaking, the resistance value). The mass is then obtained from that amount of electricity, see figure (3).

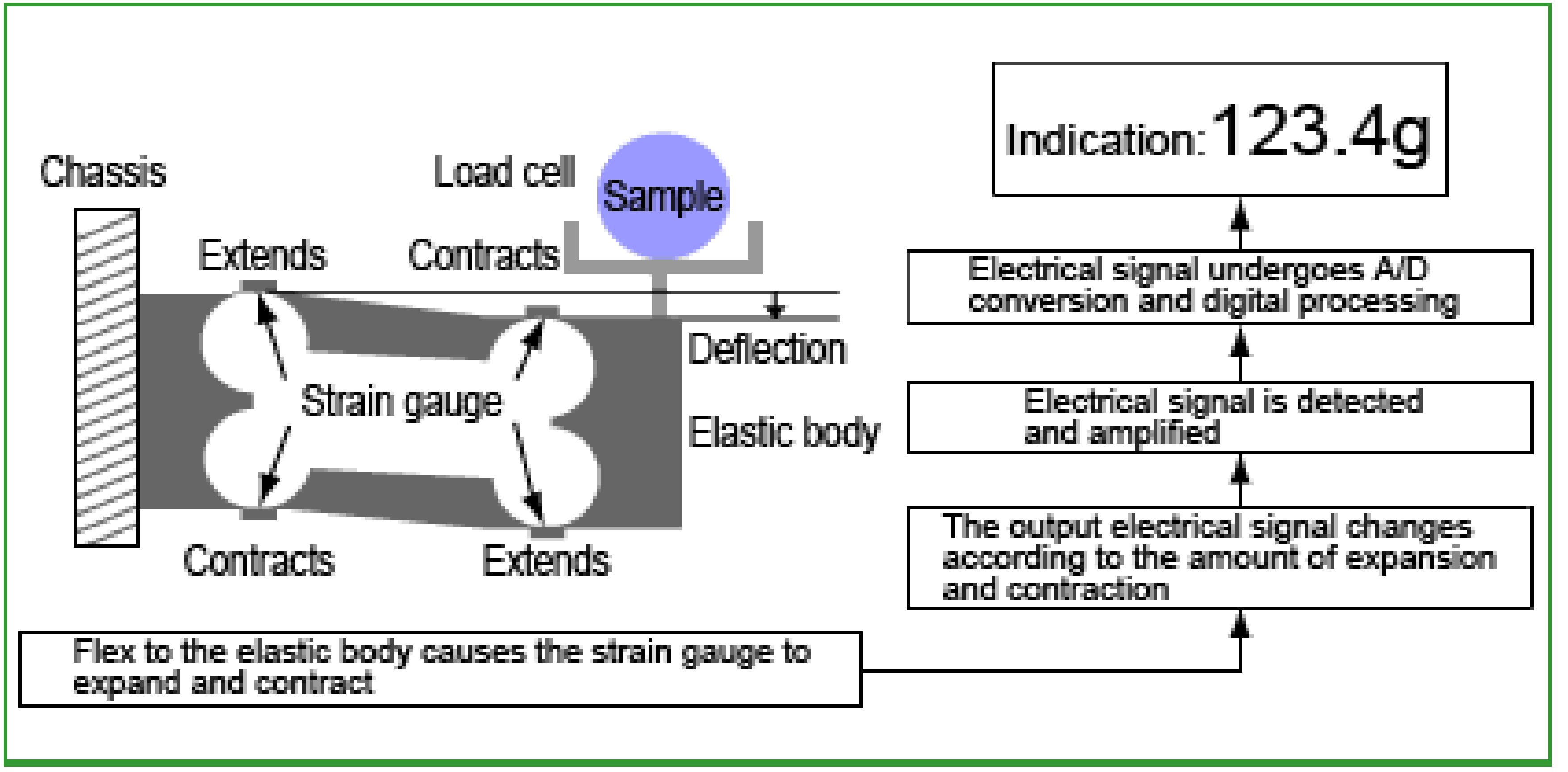


Fig (3): show how the Load cell type of electronic balance work

• Comparison between Electromagnetic Type and Load Cell Type shown in table (1).

Table (1) Comparison between Electromagnetic Type and Load Cell Type:

	Electromagnetic Type	Load Cell Type
Advantages	· High accuracy	· Simple structure · Even large models are easy to make
Disadvantages	· Complex structure · Difficult to downsize	· Accuracy is limited
Applications	· Ultra-precision balances such as analytical balances	· Small, cheap balances that require only moderate accuracy · Large balances

Weighing procedures

- Weighing and the Electronic Balance Mass determination by weighing is a fundamental and crucial task that requires a balance. While there are many kinds of balances, there are only two common weighing procedures. Mass is determined either directly or indirectly by difference. Both procedures to be self-evident and they will be utilized in the first experiment. Of the two, indirect weighing is most often used.

- You will use an electronic pan balance for all weighing. These balances are precision instruments that possess several desirable features. They are easy to use, rugged, reliable, and most importantly, it takes only a few seconds to weigh an object and determine its mass using them. There are three different brands of electronic balances in lab, but they possess similar operational characteristics. All display an object's mass directly on an LED display, and all are sensitive to the thousandths places.0.001g.

Balance Protocol

- **Use the Same Balance:** Always use the same balance throughout the experiment to maintain consistency in measurements.
- **Gather Necessary Materials:** Collect all items needed before approaching the balance, including containers, scoops, and data sheets.

Weigh by Difference (for solids):

- Weigh and record the mass of the empty container.
- Remove the container from the balance pan, add the powdered solid in small portions, and place it back on the balance.
- Record the new mass (container + solid).
- The mass of the solid is the difference between the two measurements.
- If more solid is needed, repeat the process. If too much is added, remove some and properly dispose of it.

Balance Etiquette

- The instructions on balance etiquette emphasize the importance of proper care and cleanliness to maintain the functionality of lab balances. Here are the key points:
- **Cleanliness:** Keep the balance and surrounding area free from debris. Clean up spills immediately.
- **Proper Disposal:** Dispose of used weighing paper in the trash and use the brush provided to clean up solid spills.
- **Handling Spills:** For liquid spills, notify the instructor to address the cleanup.
- **Take Items with You:** When finished weighing, remove all your items (containers, scoopula, data sheet) from the balance area.
- **Report Issues:** If the balance is not functioning properly, inform your instructor immediately.
- Following these guidelines helps ensure the balance remains accurate and in good working order for everyone in the lab.

General Faults of Balance

The electrical faults:

1. No light:

a) No power supplied to the light bulb.

b) Damage of light bulb.

c) Damage of fuse.

d) Damage of ON/OFF switch.

e) Light j bulb base is Dirty.

f) Damage of transformer/

f) The transformer input is a primary coil indicated with voltage less than 220V

General Faults of Balance

2. Weak light:

a) The transformer input is a primary coil indicated with voltage more than 220V.

b) Damage of transformer.

3. Light bulb is always on when it is connected to electric supply: Damage of ON/OFF switch.

The optical faults:

1. Light is present but all the shadow of the numbers or a part of it is not found:

a) The microfilm is wrongly placed.

b) The mirrors are wrongly placed.

2. A shadow of a line is display with all or some numbers:

a) Scratching of some mirror.

b) Scratching of microfilm.

The mechanical faults:

1. Losing the sensitivity especially with light weights:

a) Carrying weights more than the capacity of the balance.

b) Wrong dealing with balance and its adjustment.

2. Damage of leavers:

a) Wrong dealing with balance.

b) Very long using of the balance

Medical instrumentation System

Second stage

Lecture Wax bath

Assistant Lecturer

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Wax bath

- **Introduction**:
- Its medical instrument used water as a media of heat transmission. Is one of the devices the task used in physical therapy wide spread and includes the joints of the body and uses the principle of latent heat through the wax of the type which is a special wax (paraffin), which is a special kind of prefer to use because it is gaining heat slowly and lose it slowly and to keep the parties and parts warm to allow for the place.

The parts of wax bath:

1. Mechanical part.
2. Electric part.

1. Mechanical Dirt:

1. The Coat.
2. Fiber glass:
3. The external form (wax container).
4. The chamber.
5. The shelves (mesh).
6. Drain.

1. **The coat** : The coat is made of aluminum or stainless steel because resisting the mechanical shocks, resisting the oxidation & rectangle solid shape to be easily placed anywhere. The coat consists of several surfaces an isolator material prevents heat from getting outside.

2. **Fiber glass**

There are two type of it first:

a) Brown fiber glass: be somewhat cheap, but it is a dangerous substance because it causes inflammation' in the chest should be wary of dealing with.

- b) Yellow fiber glass:
- Available by many and is also a serious but less dangerous than brown, because the sensitivity and cause him to be careful to wear gloves. The advantage of fiberglass good insulator of heat and use it in your wax bath due to lack of access of heat from inside the device to the outside and maintain the internal temperature, [very bad conduction heat so it is suitable for heat insulation purpose].

3. Wax container : It is a container containing wax[paraffin wax] used in the treatment process and is made of stainless steel and be mobile in order to ease switch to different parts of the body.

4. The chamber: The chamber is completely made of aluminum or stainless steel, rectangular solid shape to suit dealing with various objects, it has thermally insulated from all other part It also contains a container of water must be distilled water because it contains salt which is responsible for melting the wax and keep it in a liquid state by heating the water by heater.

5. The shelves (mesh): The mesh is made of aluminum or steel it contains of group of holes to increase thermal conductivity.

6. Drain: It is water regulator (tube), used to vacuum the water from the chamber, it is used as manually maintenance or calibration to remove the waste water or uncomforted table water.

2. **Electric part**:

1. The power supply.
2. The heater.
3. Thermostat.
4. Temperature indicator (thermometer).
5. Timer.
6. Fuses.
7. Control panel

1. **Power supply**: The used supply in dry sterilized wax bath is 220v — 50Hz the step down transformer and rectifying circuit (AC to DC convert) to run the control panel if the parameters, numeric or other departments in the modern fashion.

2. **The heater**: The electric heating system is the system in which heating produce by rising of temperature caused by the passing of electric current through a conductor having a high resistor to current flow; it is only placed in base of the instrument.

3. **Thermostat**: Is a sensor of heat connecting directly with heater and the separation of heater in certain degrees so as to obtain the temperature we need as needed and also used to protect the device.

4. **Temperature indicator**. Tows way are used in temperature indicator there are thermometer and thermocouple & Identified for the internal temperature.

5. **Timer:** There are two type of timer electrical or mechanical at range 5-60 min given period of time required for sterilization.

6. **Fuse:** To protect the circuit from high current, high loads, short circuits.

7. **Control panel**: Contains several elements and the most important about indicator power lamp usually green & indicator heater lamp usually red & contain switch on-off and timer & knob


WAX BATH


THERABATH

• **There are three reasons to select paraffin wax**:

1. The wax vaporizes in very high temperature.
2. The wax considers low electric connectivity material.
3. The waxes miss the heat slowly& the wax keeps the heat to possible long time (20-30 minute).

Method of treatment:

1. Remove watch and rings, in the treatment area, if rings cannot be removed, cover them with several thicknesses of gauze and hold the gauze in place with masking tape.
2. Protect the patient clothing from the paraffin because it causes skin scrape (sensitivity),
3. Explain to the patient that the paraffin will feel hot, but it not burn.

4. Inspect the part to be treated:

a) The skin must be clean into the contaminate the tank. If it is not clean, the patent must be washing it with soap and water.

b) The skin must be dry and free from perspiration because it may cause burn.

c) The skin must be free from draining lesions, rashes and scratches which must be covered by gauze.

d) Check skin sensation, if skin sensation is not normal, use wax with caution.

e) Be sure the bath temperature is not over 54.4 degree centigrade.

Advantage of wax bath:

1. Fast, acting, drug, free heat therapy.
2. Proven effective to smooth pain and stiffness.
3. Effective on arthritis, joint stiffness, muscle spasms, dry cracked skin and more.
4. Versatile, safe, and easy to use.

Disadvantage of wax bath:

1. Sedimentation occurs at the bottom of the bath, the bath must be cleaned regularly at least twice a year.
2. Contamination of the wax by atmospheric dust may occurs unless the lid covers it when not use.

Faults & repair:

Which is a few faults due to the lack of electrical parts in the device because it does not contain many electronic parts and faults in this device is (heater -thermostat - sensitive — switch on/off - fuse) and the repair is to replace damaged parts .

About wax bath:

- The principle of operation of the device is heating water and the way you are melting wax is used in physical therapy and treatment is a natural by immersion may not be possible in some places access to the immersion are used way Spilling the places to be treated or using the brush to get to difficult places and prefer to use paraffin wax so as to acquisition of the heat slowly and the loss of slowly making it a good treatment of the joints to keep them warm for a long time that the treatment of the wax up (approximately 54 C) .