

# Consumer Electronics & Maintenance (4341107) - Summer 2024 Solution

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## Question 1(a) [3 marks]

Give definition (Only) of Loudness, Fidelity and Reverberation

### Solution

- **Loudness:** The subjective perception of sound intensity by the human ear, measured in decibels (dB).
- **Fidelity:** The degree to which a system reproduces sound that is faithful to the original input signal.
- **Reverberation:** The persistence of sound after the original sound source has stopped, caused by multiple reflections within an enclosed space.

### Mnemonic

“LFR: Listen Faithfully to Room echoes”

## Question 1(b) [4 marks]

Draw and explain block diagram of PA system

### Solution

PA System Block Diagram:

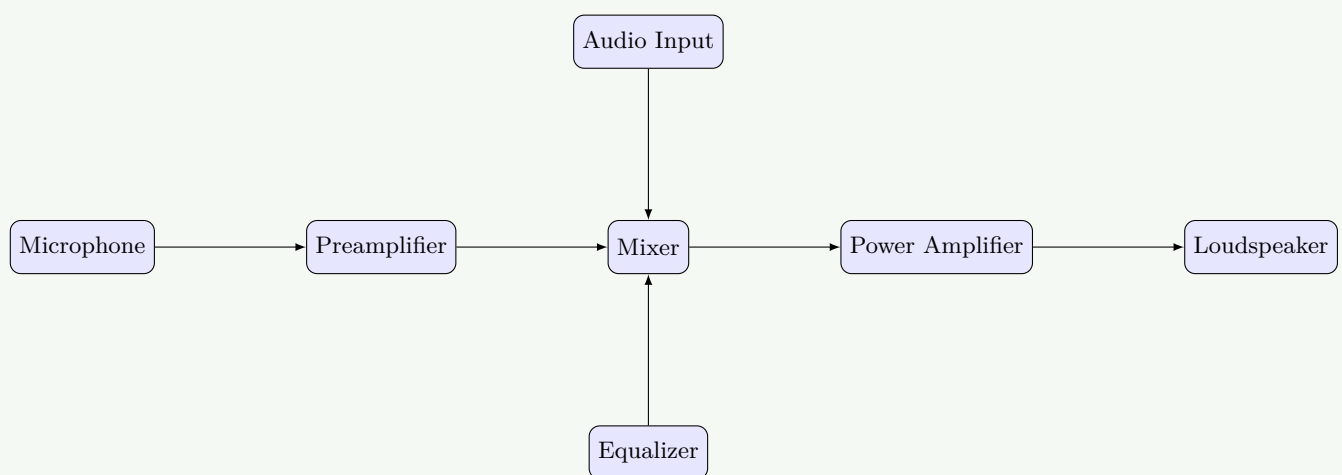


Figure 1. Public Address System

### Explanation:

- **Microphone:** Converts sound waves into electrical signals.
- **Preamplifier:** Boosts weak microphone signals to line level.

- **Mixer:** Combines multiple audio signals and adjusts levels.
- **Power Amplifier:** Increases signal power to drive loudspeakers.
- **Loudspeaker:** Converts electrical signals back into sound waves.

**Mnemonic**

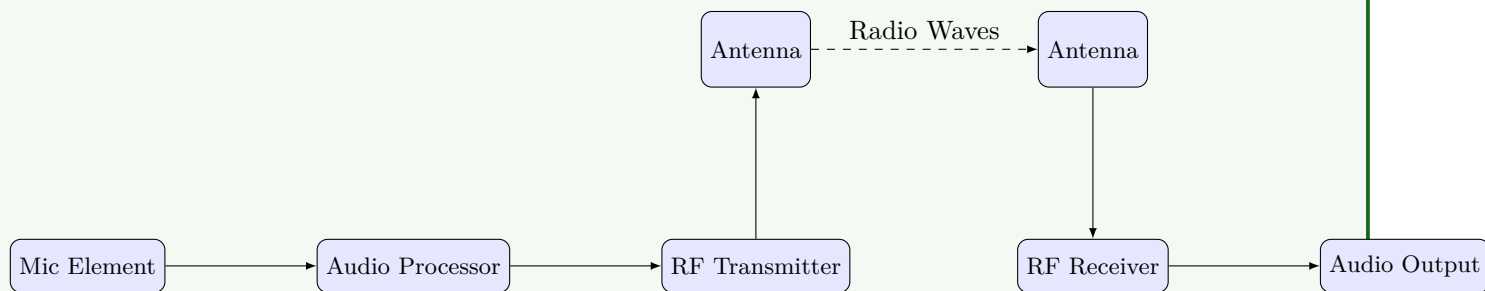
“MPMEL: Many People Make Excellent Listeners”

**Question 1(c) [7 marks]**

Discuss any two characteristic of Microphone and Explain wireless microphone

**Solution****Microphone Characteristics: Table: Microphone Characteristics**

Characteristic	Description
<b>Sensitivity</b>	Measures how efficiently microphone converts acoustic pressure to electrical output (mV/Pa)
<b>Directional Pattern</b>	Defines pickup area (omnidirectional, cardioid, hypercardioid, bidirectional)

**Wireless Microphone Working:**

**Figure 2.** Wireless Microphone System

- **Microphone Element:** Captures sound and converts to electrical signals.
- **RF Transmitter:** Modulates audio onto radio frequency carrier.
- **Transmission:** Typical frequency bands are UHF (470-698 MHz) or VHF (174-216 MHz).
- **RF Receiver:** Demodulates signal back to audio.
- **Advantages:** Mobility, no cable restrictions, reduces stage clutter.

**Mnemonic**

“SMART: Sensitivity Measures Audio Response Truly”

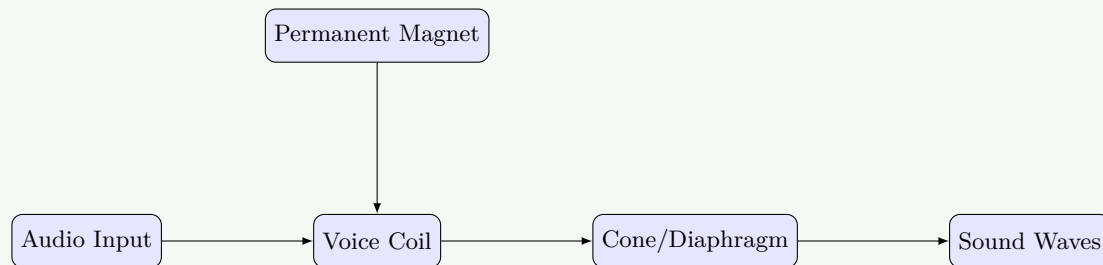
**Question 1(c) OR [7 marks]**

Discuss any two characteristics of loudspeaker and explain permanent magnet loudspeaker.

**Solution****Loudspeaker Characteristics: Table: Loudspeaker Specs**

Characteristic	Description
<b>Frequency Response</b>	Range of frequencies (Hz) speaker can reproduce (typically 20Hz-20kHz)
<b>Impedance</b>	Electrical resistance (ohms) that affects power transfer from amplifier (typically 4-8Ω)

#### Permanent Magnet Loudspeaker:



**Figure 3.** Permanent Magnet Loudspeaker

- **Permanent Magnet:** Creates fixed magnetic field (usually ferrite or neodymium).
- **Voice Coil:** Wire coil that carries audio current, creating variable magnetic field.
- **Cone/Diaphragm:** Moves in response to voice coil movement.
- **Working Principle:** Interaction between fixed magnetic field and varying field from voice coil creates mechanical movement.
- **Advantages:** More efficient, no field coil power required, compact design.

#### Mnemonic

“FIRM: Frequency Impedance Require Magnets”

## Question 2(a) [3 marks]

Define only: Aspect ratio, Luminance and chrominance

#### Solution

- **Aspect Ratio:** The ratio of width to height of a television screen (commonly 16:9 for HDTV, 4:3 for older TVs).
- **Luminance:** The brightness component of a video signal that carries intensity information (represented as Y).
- **Chrominance:** The color component of a video signal that carries color information (represented as U and V or Cb and Cr).

#### Mnemonic

“ALC: All Light Contains color”

## Question 2(b) [4 marks]

Draw PAL-D decoder only and explain separation of U and V component of chroma signal.

#### Solution

PAL-D Decoder Diagram:

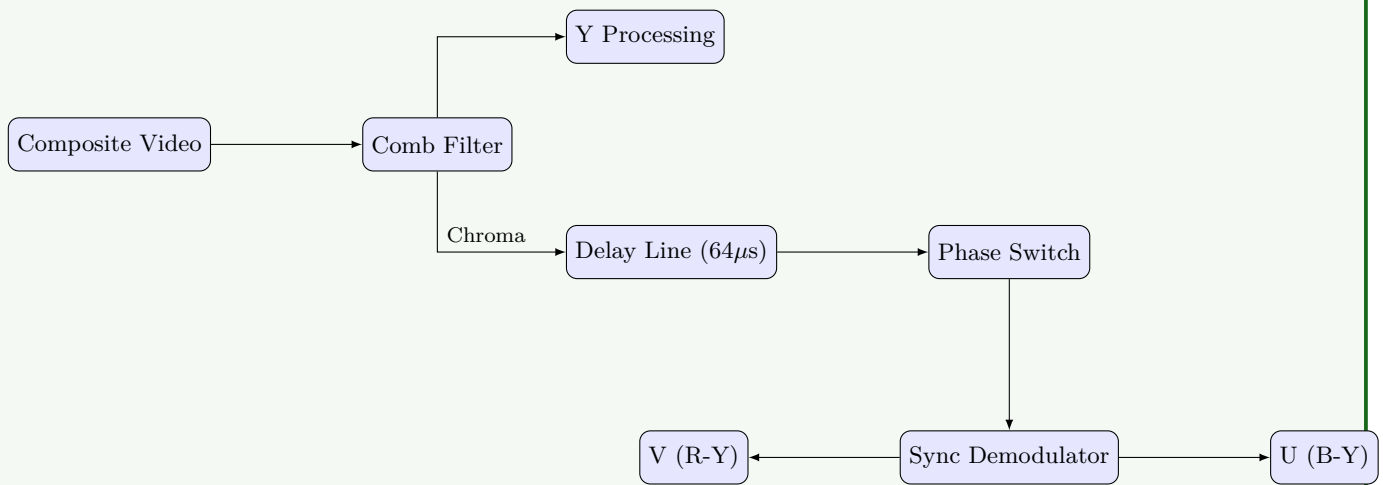


Figure 4. PAL-D Decoder

- **Comb Filter:** Separates luminance (Y) from chrominance signal.
- **Delay Line:** Delays chroma signal by one line period ( $64\mu s$ ).
- **Phase Alternating Switch:** Inverts V component on alternate lines.
- **Synchronous Demodulator:** Uses subcarrier reference to extract U and V components.
- **U Component:** Represents Blue-minus-Luminance (B-Y).
- **V Component:** Represents Red-minus-Luminance (R-Y).

#### Mnemonic

“CODES: Chrominance Only Decodes Extracting Signals”

## Question 2(c) [7 marks]

Explain in detail working of LCD television. Give any two technical specifications of it.

### Solution

#### LCD Television Working:

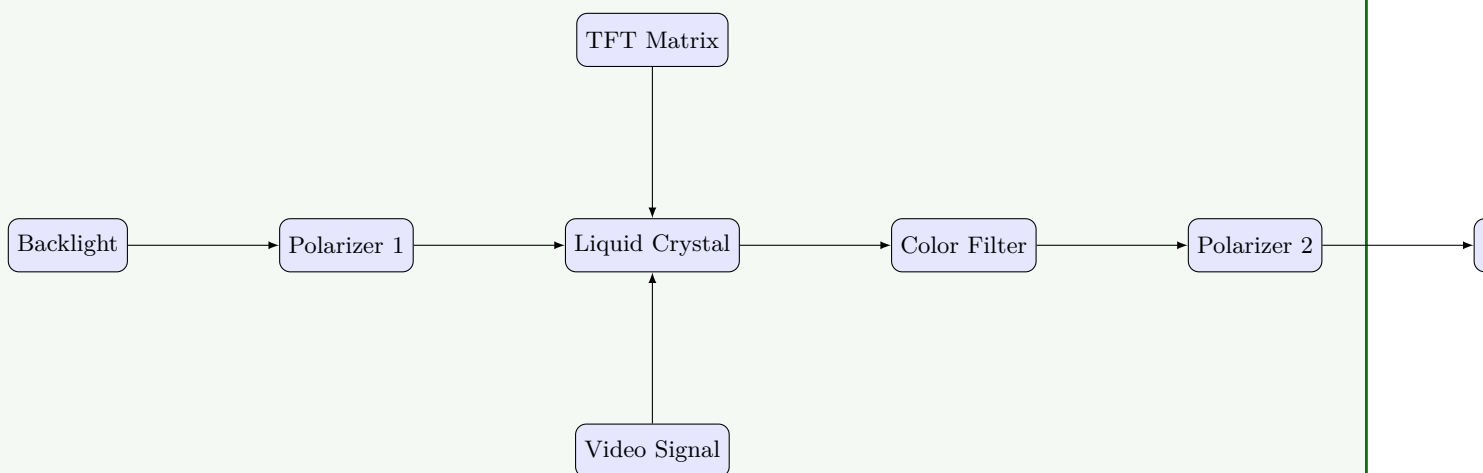


Figure 5. LCD Panel Structure

#### Working Process:

1. **Backlight:** CCFL or LED provides white light source.
2. **TFT Matrix:** Thin-film transistors control voltage to each pixel.
3. **Liquid Crystal Layer:** Molecules twist based on applied voltage.
4. **Polarizers:** First filter aligns light, second passes only rotated light.
5. **Color Filters:** RGB filters create colored pixels.
6. **Image Formation:** Varying voltage controls light passage through each pixel.

#### Technical Specifications:

- **Resolution:** 1920×1080 (Full HD) or 3840×2160 (4K UHD)
- **Refresh Rate:** 60Hz, 120Hz, or 240Hz

#### Mnemonic

“BALTIC: Backlight Activates Liquid To Illuminate Colors”

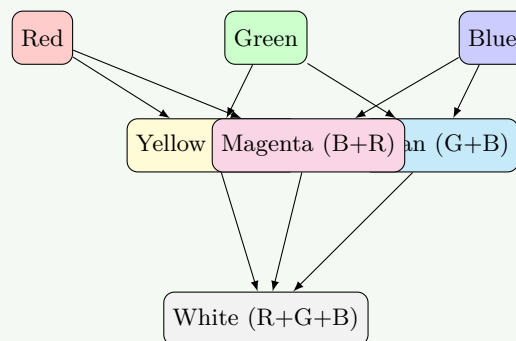
## Question 2(a) OR [3 marks]

State Grassmann's law & explain it with concept of additive mixing.

#### Solution

**Grassmann's Law:** Any color can be matched by a linear combination of three primary colors.

**Additive Color Mixing:**



**Figure 6.** Additive Color Mixing

- **Principle:** Adding light of different colors creates new colors.
- **Primary Colors:** Red, Green, and Blue.
- **Secondary Colors:** Yellow (R+G), Cyan (G+B), Magenta (B+R).
- **Example:** Equal intensities of RGB create white light.

#### Mnemonic

“RGB-ACM: Red Green Blue - Additive Creates More”

## Question 2(b) OR [4 marks]

Draw block diagram of DTH receiver and explain it.

#### Solution

**DTH Receiver Block Diagram:**

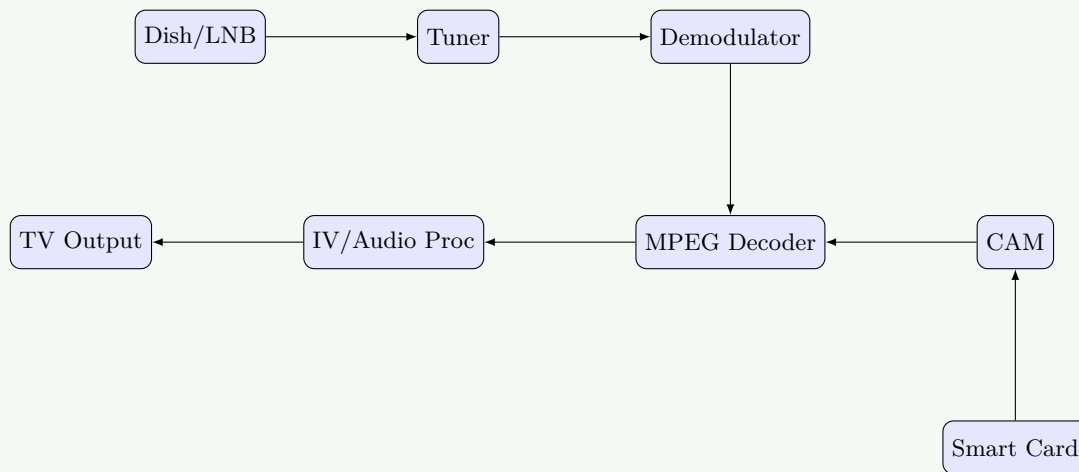


Figure 7. DTH Receiver

- **Satellite Dish:** Collects weak satellite signals (10.7-12.75 GHz).
- **LNB (Low Noise Block):** Amplifies and converts signal to lower frequency (950-2150 MHz).
- **Tuner:** Selects desired transponder frequency.
- **Demodulator:** Extracts digital data from carrier signal.
- **MPEG Decoder:** Decompresses audio/video data.
- **CAM & Smart Card:** Provide decryption and subscription verification.
- **Output:** Processes signals for display on television.

**Mnemonic**

“SLTD-MCS: Satellites Link Through Decoders Making Clear Signals”

## Question 2(c) OR [7 marks]

State following frequency/standard (used in color TV system)

**Solution**

Table: Color TV Standards (PAL-B/G)

Parameter	Frequency/Standard
VIF (Video Intermediate Frequency)	38.9 MHz
SIF (Sound Intermediate Frequency)	33.4 MHz
Color Sub-carrier Frequency	4.43361875 MHz
Vertical Blanking Frequency	50 Hz
Horizontal Synchronizing Frequency	15.625 kHz
Inter Carrier Sound Signal Frequency	5.5 MHz
One Channel Bandwidth	7 MHz (VHF), 8 MHz (UHF)

**Mnemonic**

“Very Special Colors Vertically Harmonize In One Channel”

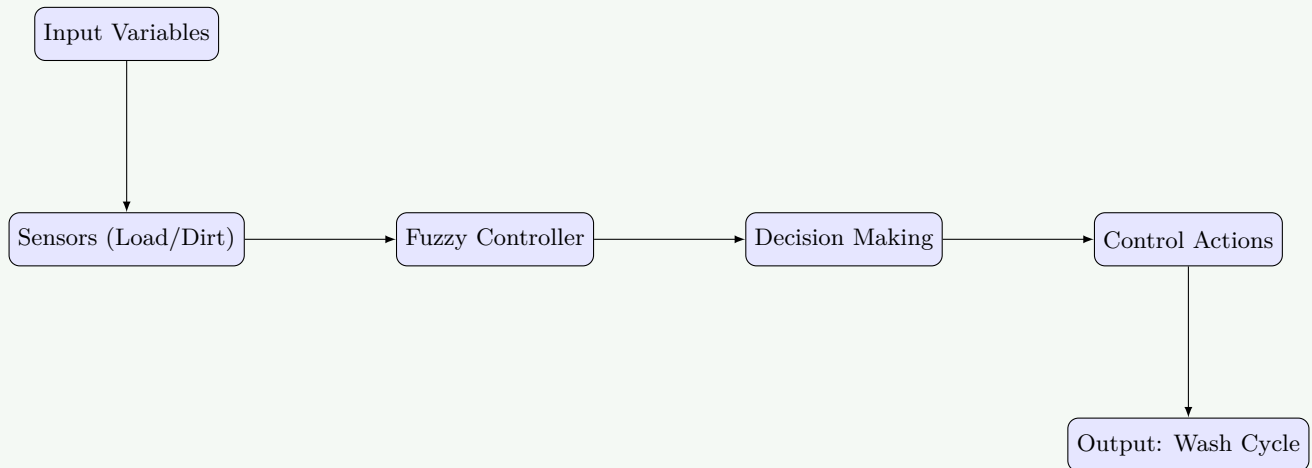
### Question 3(a) [3 marks]

What is fuzzy logic? Explain its usage in washing machine.

#### Solution

**Fuzzy Logic:** A mathematical approach that deals with approximate reasoning rather than fixed, binary logic, allowing for degrees of truth values between 0 and 1.

**Usage in Washing Machine:**



**Figure 8.** Fuzzy Logic in Washing Machine

- **Input Variables:** Load weight, fabric type, water hardness, dirt level.
- **Processing:** Controller evaluates multiple conditions simultaneously.
- **Output:** Adjusts water level, wash time, rinse cycles, spin speed.

#### Mnemonic

“FIND: Fuzzy Intelligence Navigates Decisions”

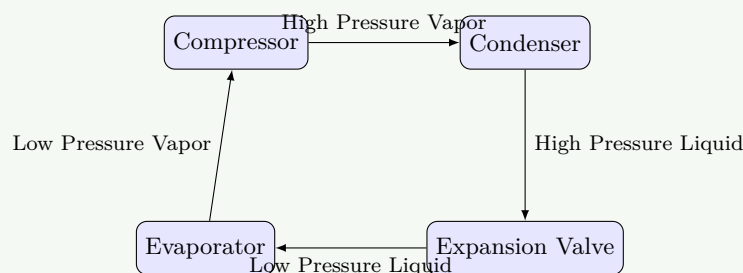
### Question 3(b) [4 marks]

Define air conditioning. Explain working of fridge. State its technical specification.

#### Solution

**Air Conditioning:** The process of removing heat and moisture from indoor air to improve comfort.

**Refrigerator Working Cycle:**



**Figure 9.** Refrigeration Cycle

**Working Steps:**

1. **Compressor:** Compresses refrigerant gas, raising temperature.
2. **Condenser:** Hot gas releases heat to outside, becomes liquid.
3. **Expansion Valve:** Liquid expands, cools rapidly.
4. **Evaporator:** Cold refrigerant absorbs heat from inside cabinet.

**Technical Specifications:**

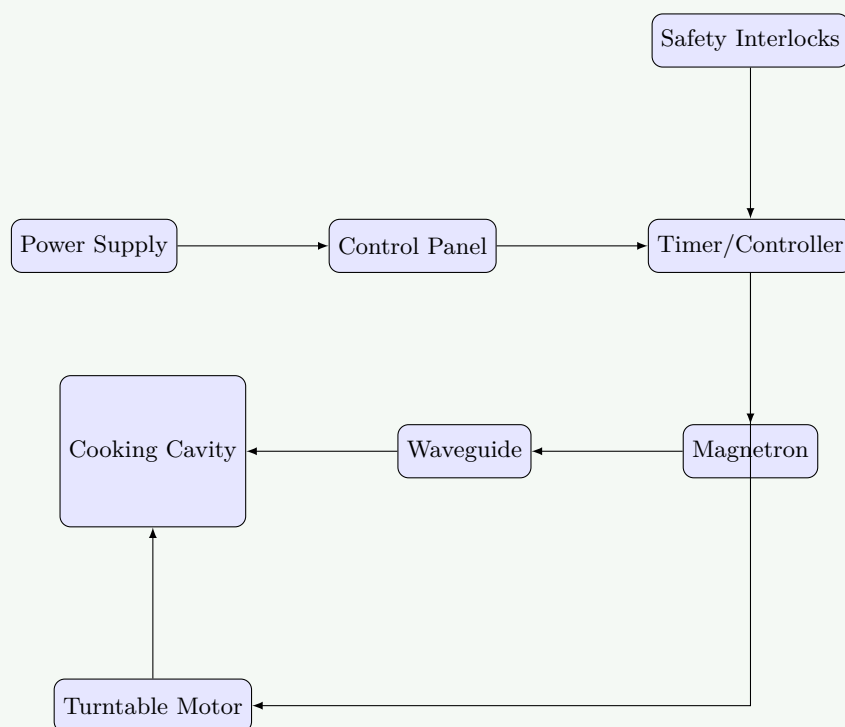
- **Capacity:** 150-500 liters
- **Energy Rating:** 3-5 Star
- **Power Consumption:** 100-300 kWh/year

**Mnemonic**

“CEVA: Compress, Expel heat, Valve expands, Absorb heat”

**Question 3(c) [7 marks]**

Explain working principle of Microwave oven using functional block diagram. State its technical specifications.

**Solution****Microwave Oven Block Diagram:**

**Figure 10.** Microwave Oven System

**Working Principle:**

1. **Magnetron:** Generates microwaves at 2.45 GHz frequency.
2. **Waveguide:** Directs microwaves into cooking cavity.
3. **Water Molecules:** Microwaves cause water molecules to vibrate.
4. **Heat Generation:** Molecular vibration creates friction and heat.
5. **Turntable:** Rotates food for even cooking.
6. **Safety Interlocks:** Prevent operation when door is open.



**Technical Specifications:**

- **Power Output:** 700-1200 watts
- **Frequency:** 2.45 GHz
- **Capacity:** 20-40 liters
- **Cooking Modes:** Microwave, Grill, Convection, Combination

**Mnemonic**

“MICRO: Magnetron Initiates Cooking by Rotating Oscillations”

**Question 3(a) OR [3 marks]**

Give technical specification of solar panel. State advantages and disadvantages of solar roof top system

**Solution****Solar Panel Technical Specifications:**

- **Power Rating:** 250-400 Wp (Watt peak)
- **Efficiency:** 15-22%
- **Cell Type:** Monocrystalline, Polycrystalline, or Thin Film

**Advantages and Disadvantages:**

Advantages	Disadvantages
Renewable Energy Source	High Initial Cost
Reduces Electricity Bills	Weather Dependent
Low Maintenance Cost	Requires Large Space
No Noise Pollution	Limited Nighttime Generation

**Mnemonic**

“SERLN: Solar Energy Reduces Long-term Numbers”

**Question 3(b) OR [4 marks]**

State various types of washing machine. Compare frontload and top load washing machine.

**Solution****Types of Washing Machines:**

- Top Load (Agitator & Impeller)
- Front Load
- Semi-Automatic
- Fully Automatic

**Comparison:**

Parameter	Front Load	Top Load
<b>Water Consumption</b>	Lower (40-60 liters)	Higher (80-120 liters)
<b>Energy Efficiency</b>	Higher	Lower
<b>Cleaning Performance</b>	Better	Good
<b>Space Requirement</b>	Can be stacked	Needs top clearance
<b>Cost</b>	Higher	Lower
<b>Cycle Duration</b>	Longer (60-120 min)	Shorter (30-60 min)

**Mnemonic**

“FTEST: Front-loaders Take Extra Space but Triumph in efficiency”

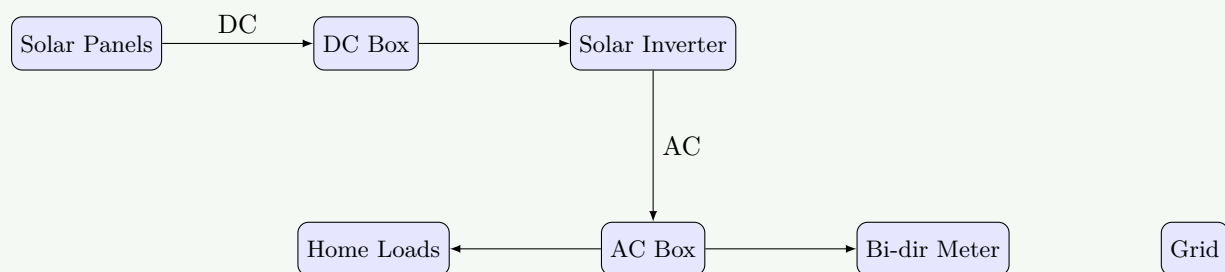
**Question 3(c) OR [7 marks]**

Give classification of solar rooftop system. Explain working of solar rooftop system (Grid connected online) with suitable diagram. State steps to maintain solar roof top system.

**Solution**

**Classification:** Grid-Connected (On-grid), Off-Grid (Standalone), Hybrid.

**Grid-Connected Solar System Diagram:**



**Figure 11.** On-Grid Solar System

**Working:**

1. **Solar Panels:** Convert sunlight to DC electricity.
2. **Junction Box:** Combines outputs, provides protection.
3. **Inverter:** Converts DC to grid-compatible AC.
4. **Bi-directional Meter:** Measures import/export of electricity.
5. **Excess Generation:** Feeds back to grid (Net metering).

**Maintenance Steps:**

- Regular cleaning of panels (dust, bird droppings).
- Checking electrical connections for corrosion.
- Monitoring system performance via inverter data.
- Trimming nearby trees to prevent shading.
- Annual inspection by qualified technician.

**Mnemonic**

“SPICED: Solar Panels Invert Current for Electrical Distribution”

**Question 4(a) [3 marks]**

Explain in brief working principle of photo copier machine with concept of latent image.

**Solution**

**Photocopier Process:**

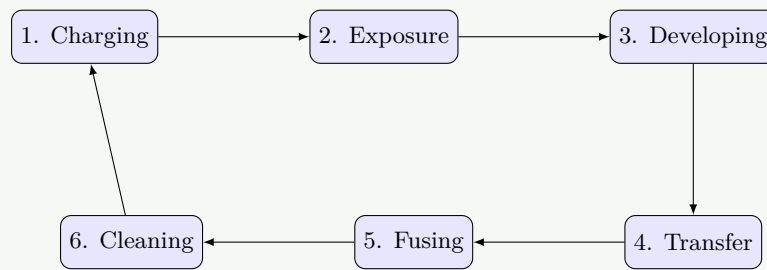


Figure 12. Xerography Cycle

**Latent Image Concept:**

- **Charging:** Photosensitive drum receives uniform positive charge.
- **Exposure:** Light reflects from original document onto drum.
- **Latent Image:** Light areas discharge drum creating invisible electrostatic image.
- **Development:** Negatively charged toner particles attracted to positive areas.
- **Transfer:** Toner transferred to paper through electrical attraction.
- **Fusing:** Heat and pressure permanently bond toner to paper.

**Mnemonic**

“CEDTFC: Charging Exposure Develops The Final Copy”

**Question 4(b) [4 marks]**

Explain working of Laser printer with suitable diagram

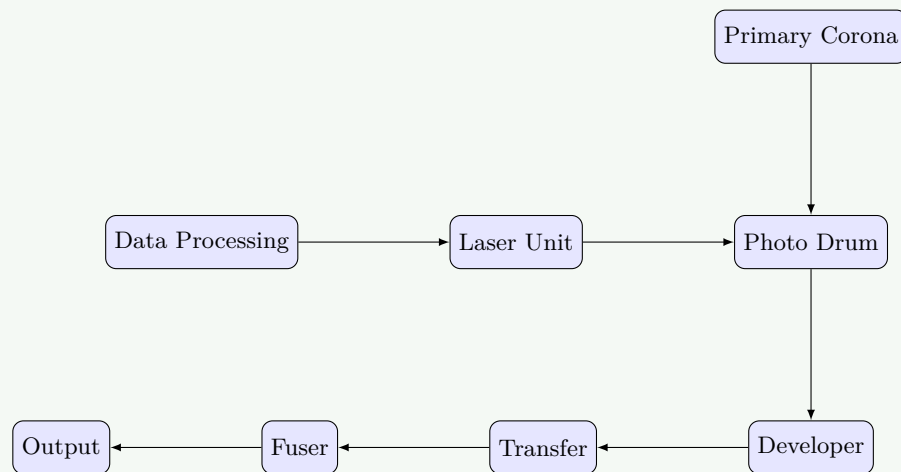
**Solution****Laser Printer Diagram:**

Figure 13. Laser Printer Mechanism

**Working Process:**

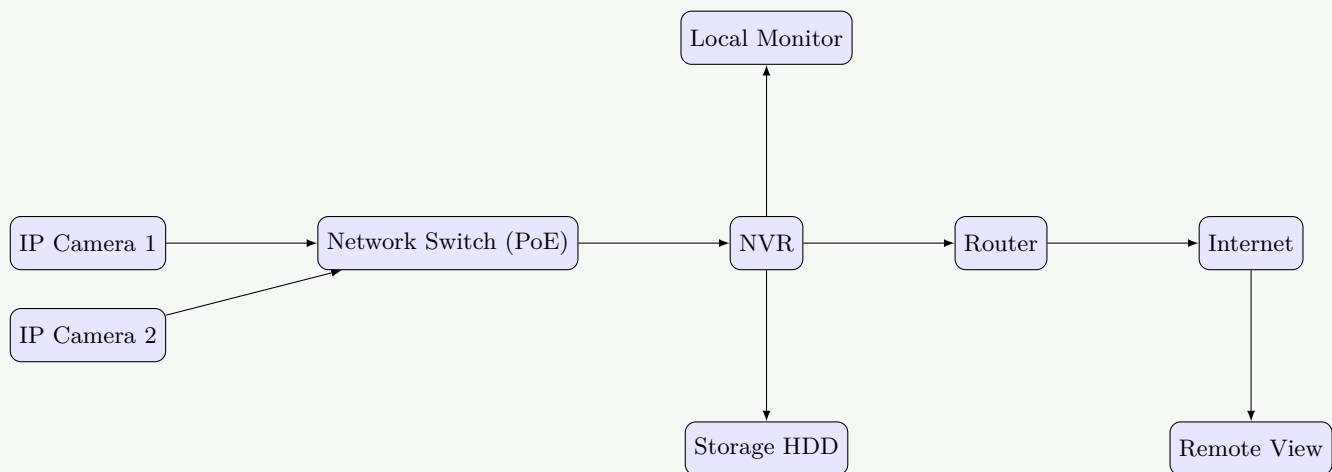
- **Raster Image Processing:** Computer data converted to bitmap.
- **Charging:** Corona wire gives drum uniform negative charge.
- **Writing:** Laser beam neutralizes charge in pattern of image.
- **Developing:** Toner attracted to neutralized areas.
- **Transfer:** Paper given positive charge to attract toner.
- **Fusing:** Heat rollers melt toner permanently onto paper.

**Mnemonic**

“RASTER: Raster-image Attracts Static Toner, Electricity Releases”

**Question 4(c) [7 marks]**

Draw and explain block diagram of CCTV system using Digital IP camera connected with internet...

**Solution****IP CCTV System Diagram:**

**Figure 14.** IP CCTV Architecture

**Working:**

- **IP Cameras:** Capture and digitize video.
- **Network Infrastructure:** Transmits data via TCP/IP protocols.
- **NVR:** Records, manages, and processes video streams.
- **Router:** Provides secure internet access for remote viewing.

**Camera Types:** Dome, Bullet, PTZ, Fisheye, Thermal.

**PoE Cable:** Power Over Ethernet carries both power and data on a single cable.

**Mnemonic**

“INSPIRE: Internet Networking Secures Places In Remote Environments”

**Question 4(a) OR [3 marks]**

Discuss pros and cons of internet based Digital IP camera CCTV system

**Solution**

Pros	Cons
Higher Resolution (1080p to 4K)	Higher Initial Cost
Remote Viewing via internet	Bandwidth Requirements
Scalability & easy expansion	Cybersecurity Risks
Power Over Ethernet (POE)	Network Dependency
Advanced Analytics capabilities	Complex Configuration

**Mnemonic**

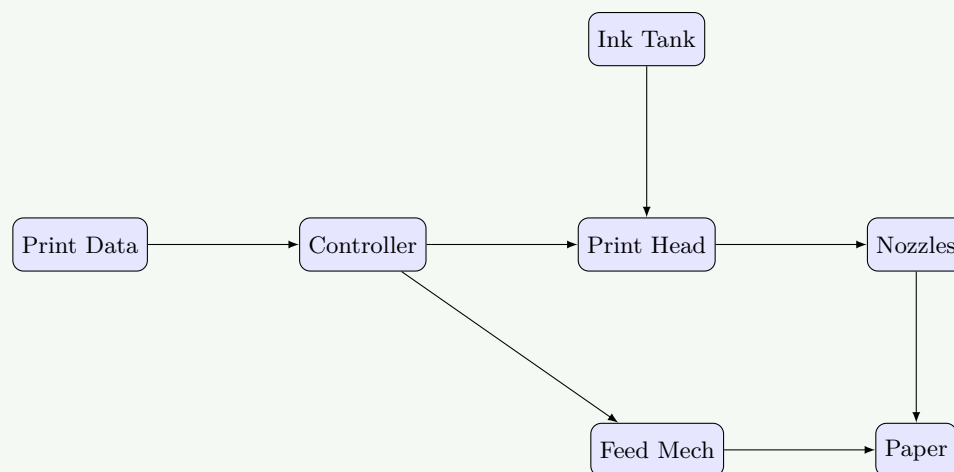
“HIGHER: High-resolution Images Give Higher Evaluation Remotely”

**Question 4(b) OR [4 marks]**

Explain working of inkjet printer with suitable diagram

**Solution**

**Inkjet Printer Diagram:**



**Figure 15.** Inkjet Working

**Working Process:**

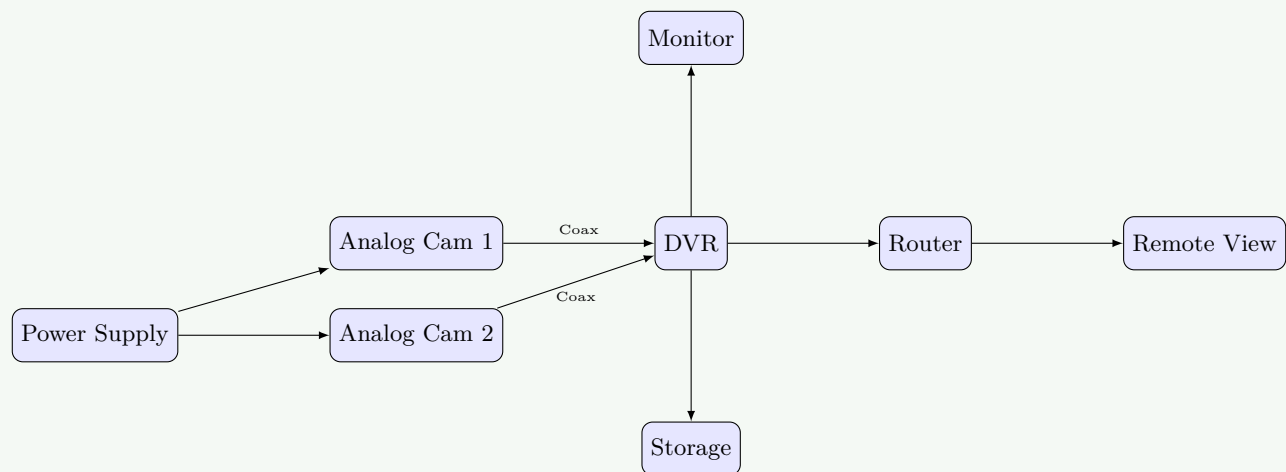
- **Data Processing:** Controller converts digital data to nozzle instructions.
- **Ink Ejection:**
  - Thermal: Resistors heat ink to create bubbles.
  - Piezoelectric: Crystals flex to push ink.
- **Drying:** Ink adheres to paper surface.

**Mnemonic**

“PRINT: Paper Receives Ink through Numerous Tiny-nozzles”

**Question 4(c) OR [7 marks]**

Draw and explain block diagram of CCTV system using simple analog camera and DVR...

**Solution****Analog CCTV Diagram:****Figure 16.** Analog CCTV System

**Cable Types:** Coaxial (RG59), Twisted Pair (CAT5/6), Power Cable, Fiber Optic, Siamese Cable.

**Camera Categories:** Fixed, Varifocal, Night Vision, HDR.

**Mnemonic**

“CARD: Coaxial Analog Recording Devices”

**Question 5(a) [3 marks]**

Define only: Maintenance, Preventive maintenance and Predictive maintenance.

**Solution**

- **Maintenance:** Process of preserving equipment in proper operating condition.
- **Preventive Maintenance:** Scheduled activities to prevent failures before they occur.
- **Predictive Maintenance:** Condition-based maintenance using data to predict failure timing.

**Mnemonic**

“MPP: Maintain Proactively, Predict problems”

**Question 5(b) [4 marks]**

Discuss maintenance of public address system.

**Solution**

Component	Maintenance Tasks
<b>Microphones</b>	Clean windscreens, Check cables, Test sensitivity
<b>Amplifiers</b>	Clean vents, Check power, Inspect overheating
<b>Speakers</b>	Inspect brackets, Test for distortion, Check wiring
<b>Cables</b>	Test continuity, Replace damaged cables

**Mnemonic**

“MACS: Microphones, Amplifiers, Connections, Speakers”

**Question 5(c) [7 marks]**

State any three faults of washing machine. Discuss in general maintenance of washing machine.

**Solution****Common Faults:**

1. **Water Not Filling:** Faulty valve, clogged filter.
2. **Not Spinning:** Belt issues, motor problems.
3. **Excessive Vibration:** Uneven feet, suspension issues.

**Maintenance Procedures:**

Component	Tasks
<b>Drum</b>	Clean monthly, remove residue, check foreign objects
<b>Filters</b>	Clean lint filter after use, pump filter monthly
<b>Hoses</b>	Inspect cracks, replace every 3-5 years
<b>Door Seal</b>	Wipe to prevent mold, check for tears

**Mnemonic**

“WATCH: Water And Tub Cleaning Helps”

**Question 5(a) OR [3 marks]**

Compare predictive and preventive maintenance.

**Solution**

Param	Predictive	Preventive
<b>Timing</b>	As needed (condition-based)	Fixed schedule
<b>Tech</b>	Vibration/Thermal analysis	Visual inspection/Cleaning
<b>Cost</b>	High initial, low long-term	Low initial, maybe high long-term
<b>Downtime</b>	Minimized/Planned	Systematic scheduled

**Mnemonic**

“TIMED: Testing Identifies Maintenance Exactly when Due”

## Question 5(b) OR [4 marks]

Discuss maintenance and troubleshooting of LCD TV.

### Solution

#### Maintenance:

- **Screen:** Clean with microfiber, no liquids.
- **Ventilation:** Remove dust, ensure airflow.
- **Connections:** Verify cables, check corrosion.

#### Troubleshooting:

- **No Power:** Check cord, fuse.
- **No Picture:** Verify backlight, T-Con board.
- **Lines on Screen:** Ribbon cables, screen damage.

#### Mnemonic

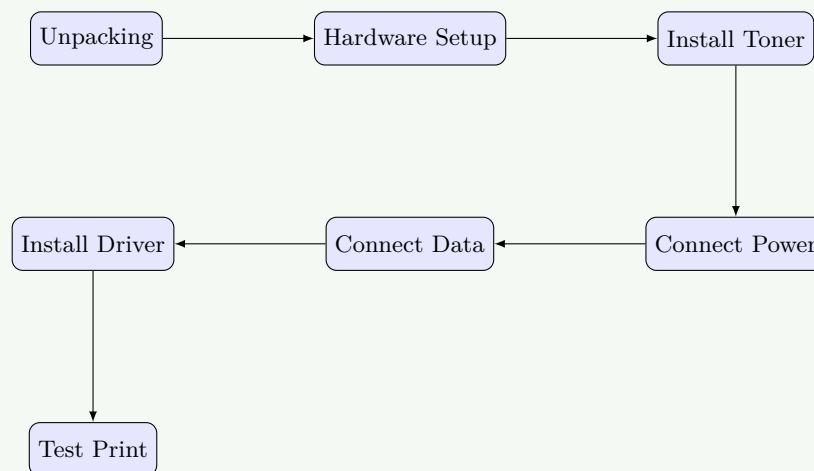
“PVCS: Pixels, Ventilation, Connections, Software”

## Question 5(c) OR [7 marks]

Explain installation of laser printers in your computer system. Discuss its maintenance and troubleshooting procedure.

### Solution

#### Installation Diagram:



**Figure 17.** Printer Installation

#### Maintenance:

- **Paper Path:** Clean with compressed air.
- **Rollers:** Clean with isopropyl alcohol.
- **Toner Area:** Vacuum carefully.

**Troubleshooting:** Paper jams (Clear path), Streaking (Clean corona), Light print (Replace toner), Connection issues (Reinstall driver).

#### Mnemonic

“SECURE: Setup, Execute drivers, Clean Regularly, Update, Replace consumables, Examine problems”