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:

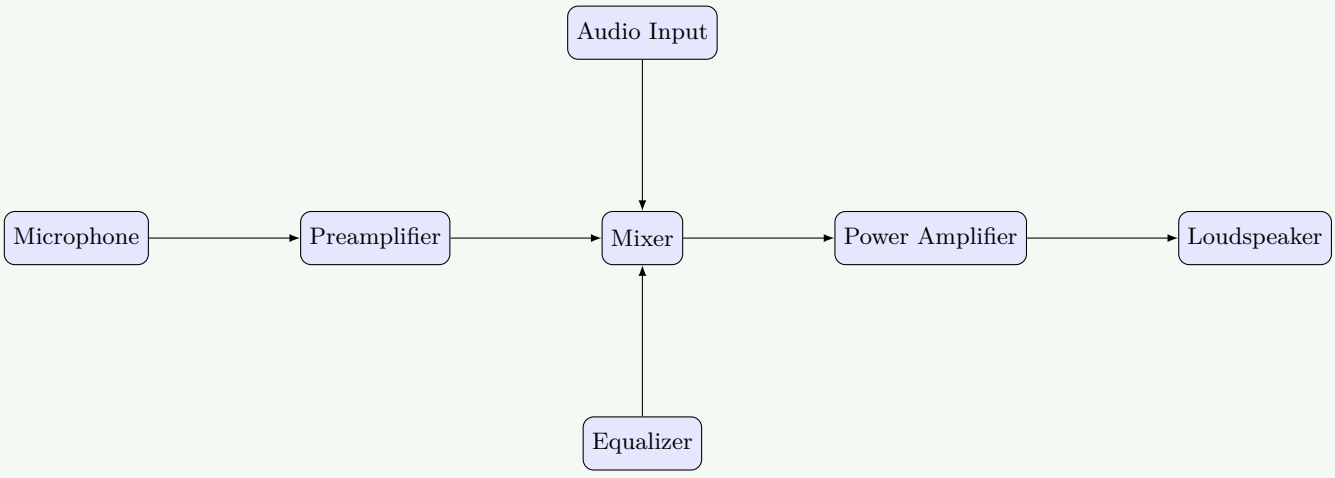

Figure 1. Public Address System

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

Wireless Microphone Working:

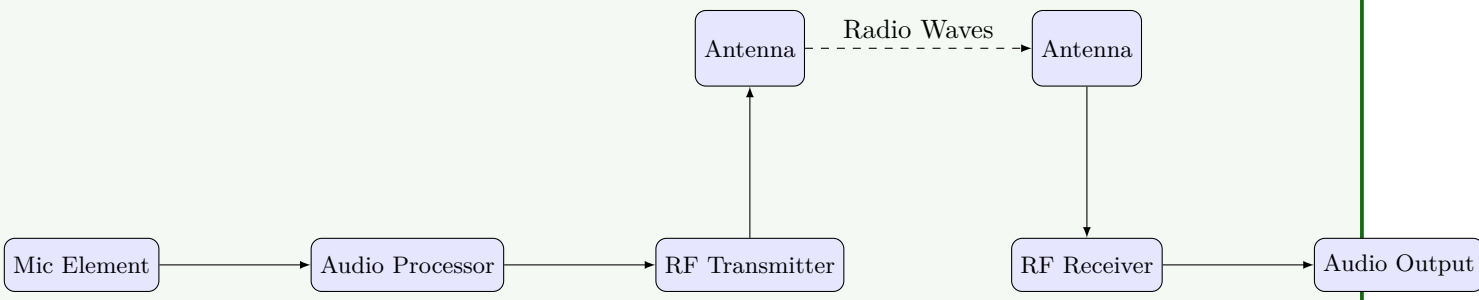

Figure 2. Wireless Microphone System

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

Permanent Magnet Loudspeaker:

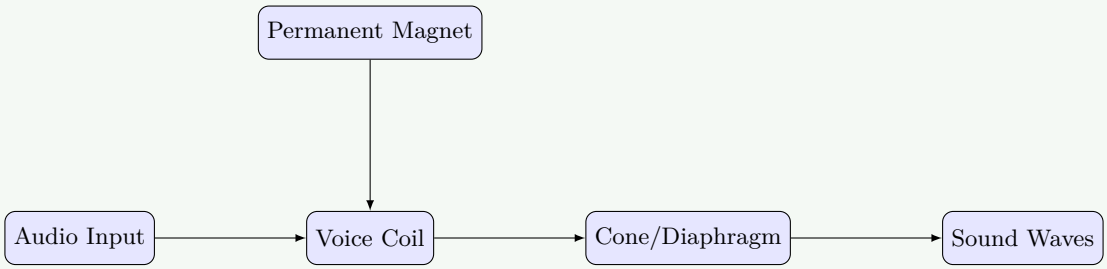

Figure 3. Permanent Magnet Loudspeaker

- **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:

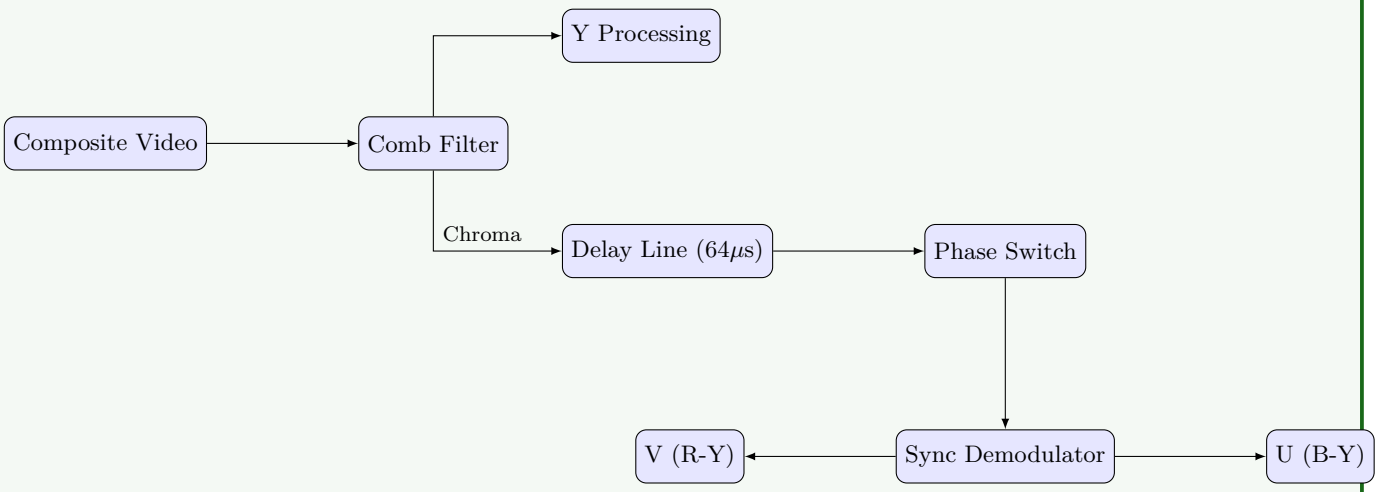

Figure 4. PAL-D Decoder

- **Comb Filter**: Separates luminance (Y) from chrominance signal.
- **Delay Line**: Delays chroma signal by one line period (64μs).
- **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:

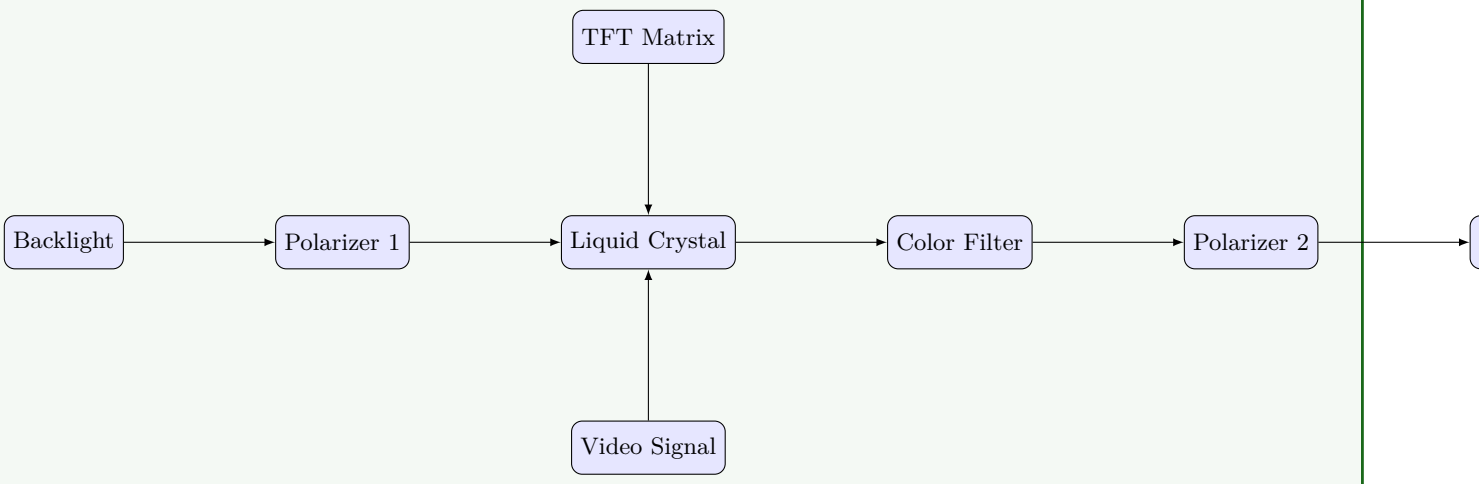

Figure 5. LCD Panel Structure

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 Grassmens 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:

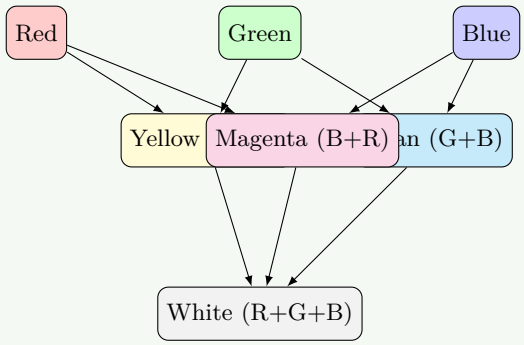

Figure 6. Additive Color Mixing

- **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:

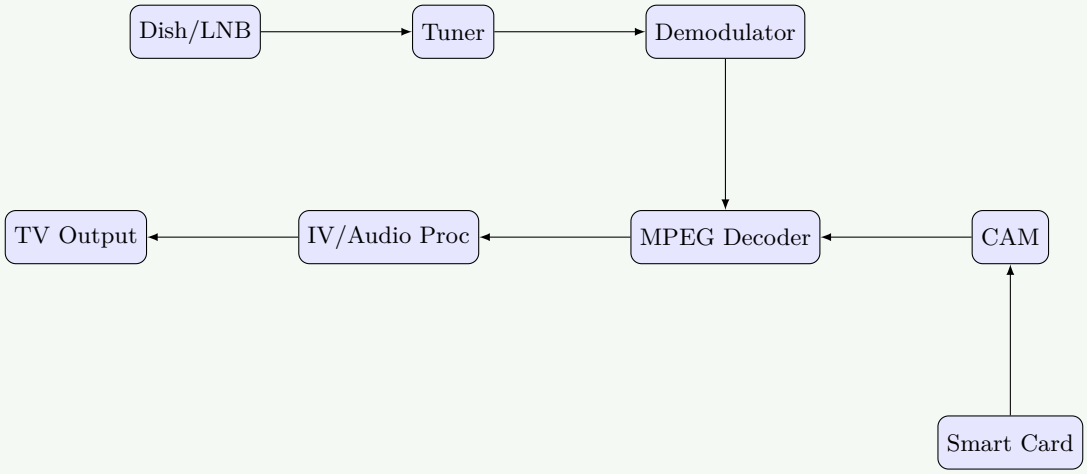

Figure 7. DTH Receiver

- **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:

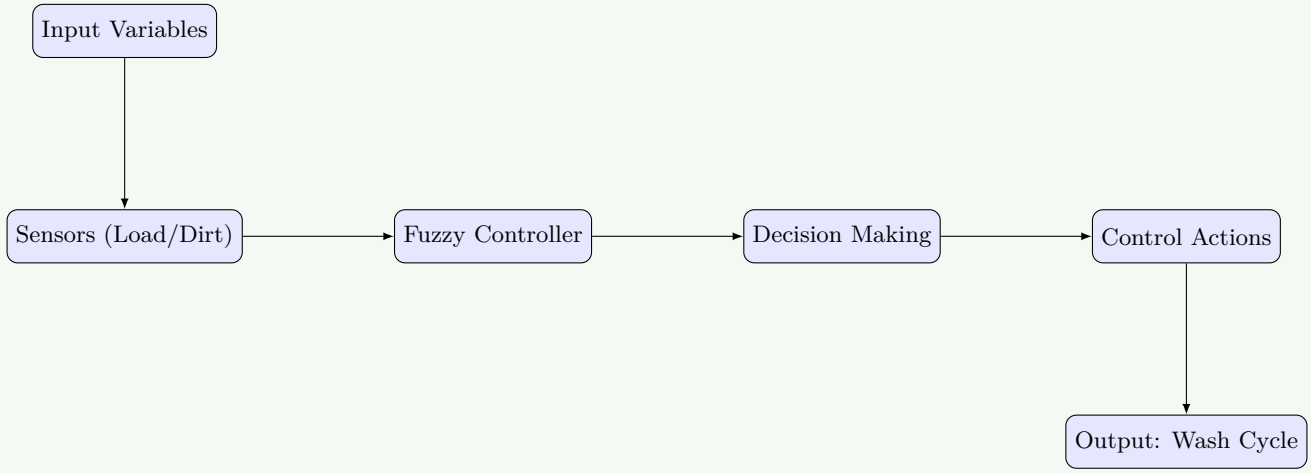

Figure 8. Fuzzy Logic in Washing Machine

- **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:

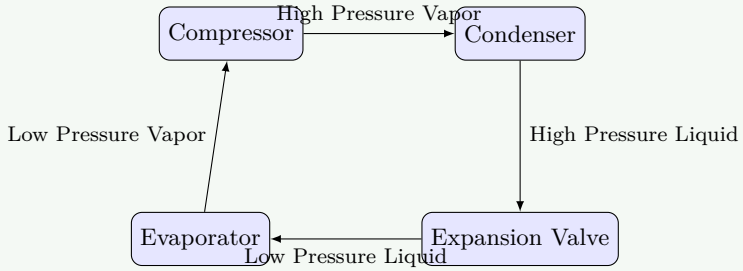

Figure 9. Refrigeration Cycle

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:

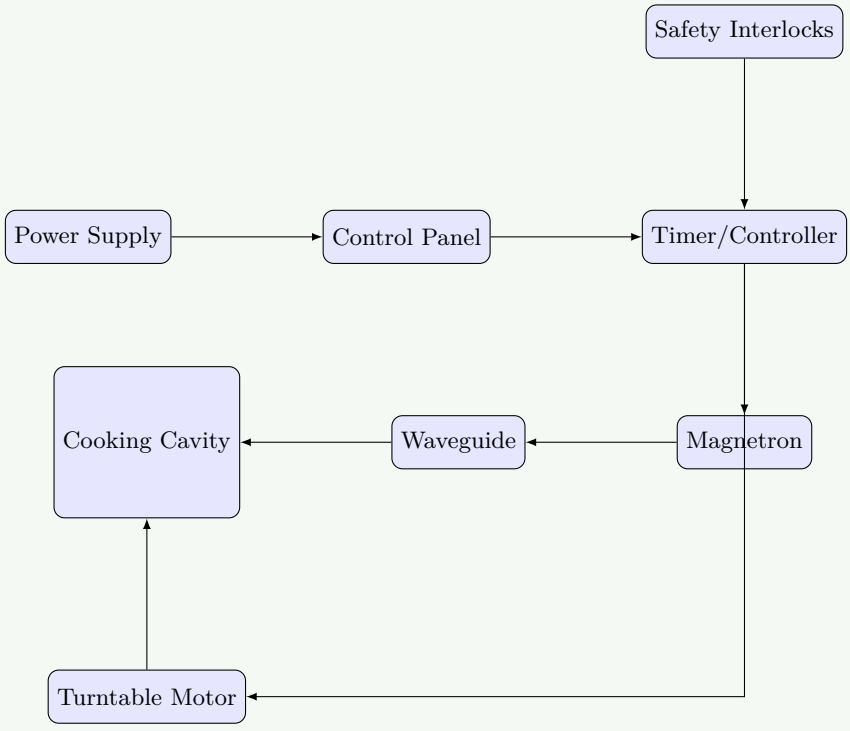

Figure 10. Microwave Oven System

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
Water Consumption	Lower (40-60 liters)	Higher (80-120 liters)
Energy Efficiency	Higher	Lower
Cleaning Performance	Better	Good
Space Requirement	Can be stacked	Needs top clearance
Cost	Higher	Lower
Cycle Duration	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:

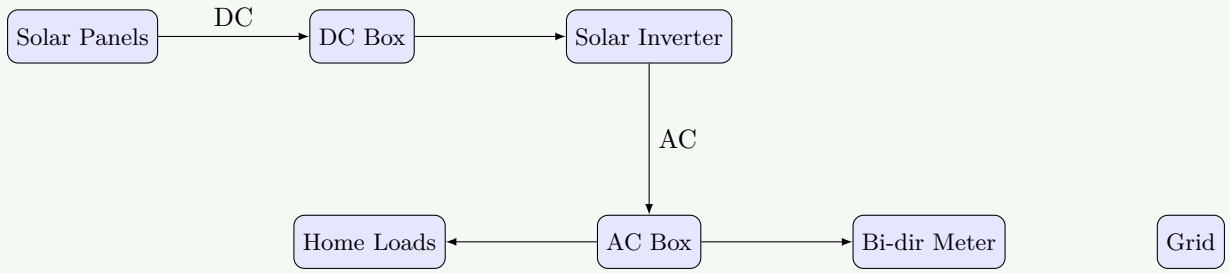

Figure 11. On-Grid Solar System

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:

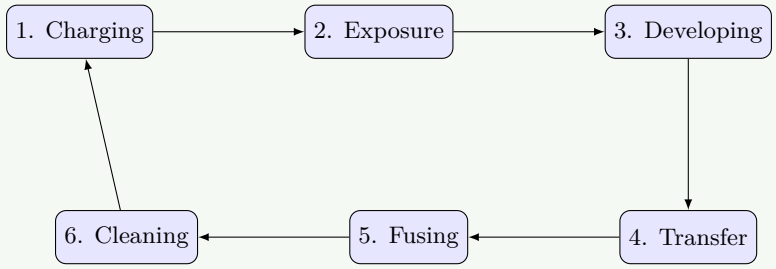

Figure 12. Xerography Cycle

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:

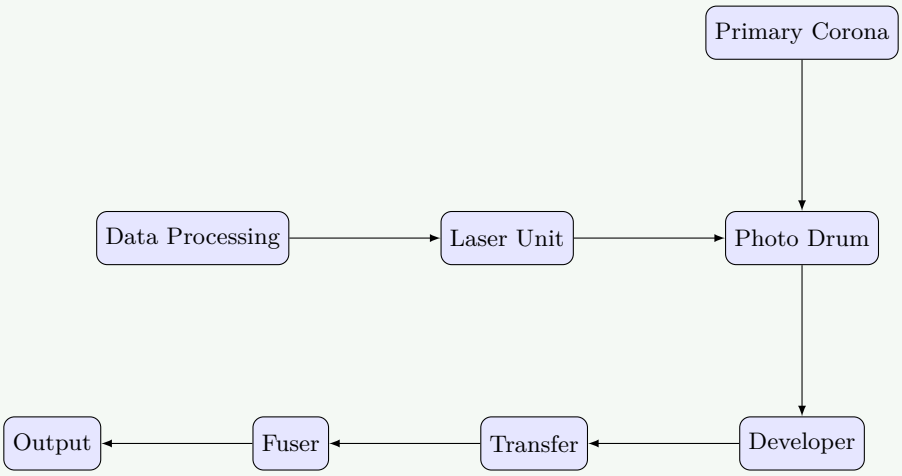

Figure 13. Laser Printer Mechanism

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:

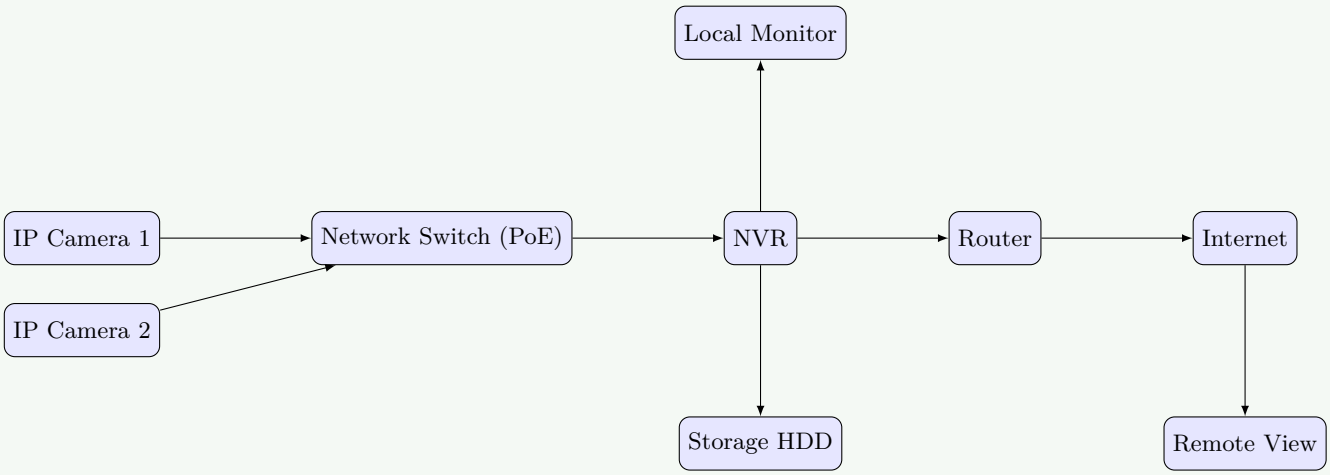

Figure 14. IP CCTV Architecture

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:

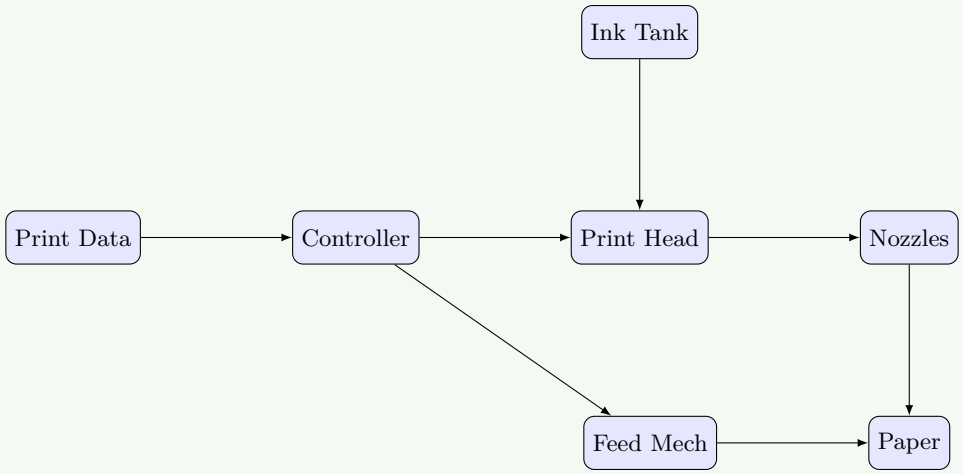

Figure 15. Inkjet Working

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:

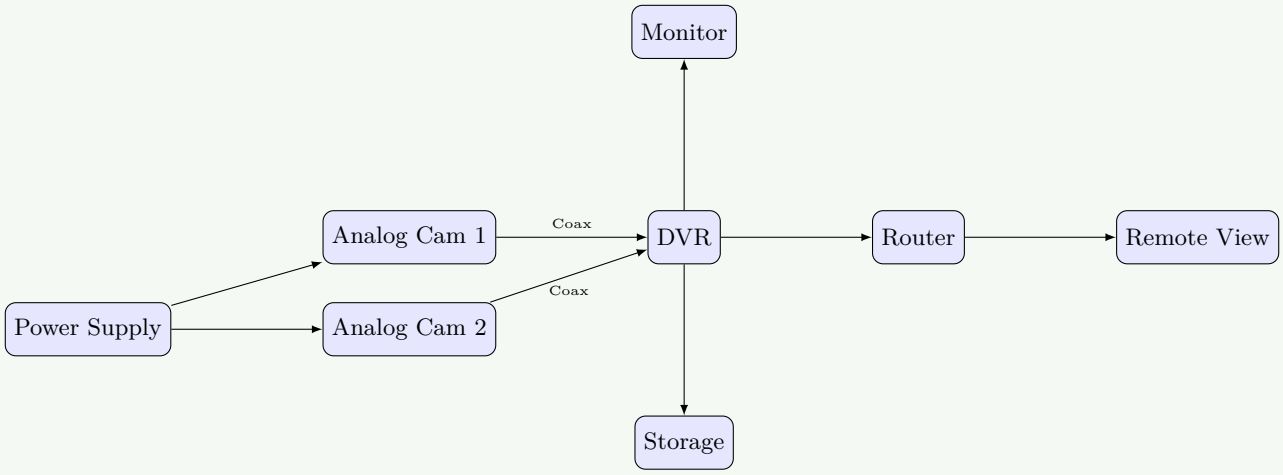

Figure 16. Analog CCTV System

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
Microphones	Clean windscreens, Check cables, Test sensitivity
Amplifiers	Clean vents, Check power, Inspect overheating
Speakers	Inspect brackets, Test for distortion, Check wiring
Cables	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
Drum	Clean monthly, remove residue, check foreign objects
Filters	Clean lint filter after use, pump filter monthly
Hoses	Inspect cracks, replace every 3-5 years
Door Seal	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
Timing	As needed (condition-based)	Fixed schedule
Tech	Vibration/Thermal analysis	Visual inspection/Cleaning
Cost	High initial, low long-term	Low initial, maybe high long-term
Downtime	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:

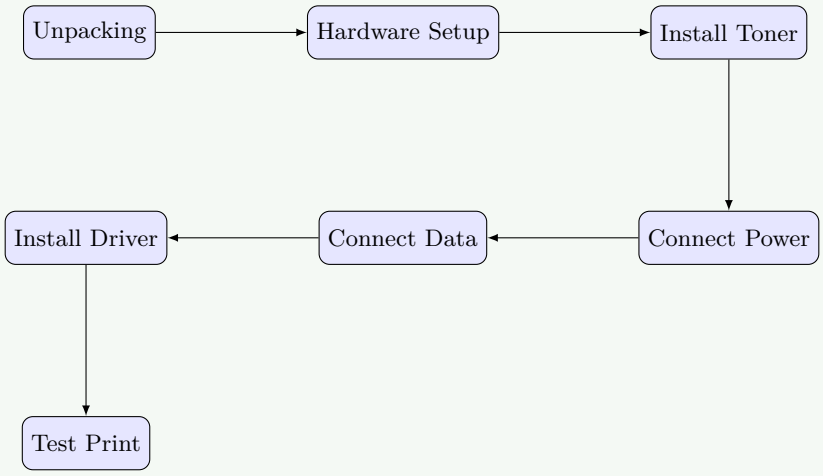

Figure 17. Printer Installation

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"