Consumer Electronics & Maintenance (4341107) - Winter 2024 Solution

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Question 1(a) [3 marks]

Define only: 1. Loudness 2. Timbre 3. Echo

Solution

Term	Definition
Loudness	The subjective perception of sound intensity that depends on sound pressure and frequency
Timbre	The quality of sound that distinguishes different instruments or voices playing the same note
Echo	A sound reflection that arrives at the listener with a delay greater than 50ms after the direct sound

Mnemonic

"LTE: Loudness measures strength, Timbre gives uniqueness, Echo comes back delayed"

Question 1(b) [4 marks]

List Type of loudspeaker and explain any one of them

Solution

Types of Loudspeakers:

- Dynamic/Moving Coil (Electromagnetic)
- Electrostatic (Charged diaphragm)
- Ribbon (Thin metal ribbon)
- Piezoelectric (Vibrating crystals)
- Horn (Acoustic amplification)
- Planar Magnetic (Magnetic strips)

Dynamic/Moving Coil Loudspeaker:

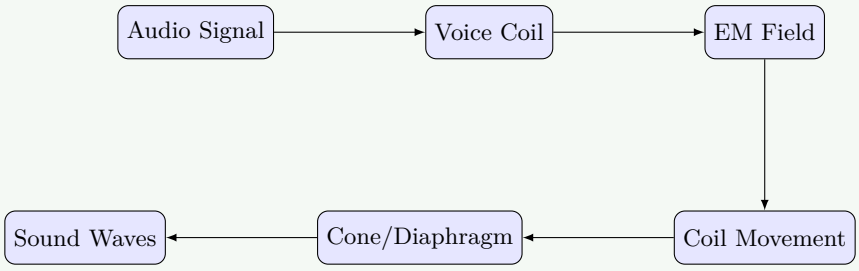

Figure 1. Dynamic Loudspeaker Working

- **Magnetic Structure**: Permanent magnet creates static magnetic field.
- **Voice Coil**: Receives audio current and creates varying magnetic field.
- **Diaphragm/Cone**: Attached to voice coil, vibrates to produce sound waves.

Mnemonic

"COPPER-D: Coil Oscillates, Permanent magnet Pulls/Pushes, Emitting Resonance through Diaphragm"

Question 1(c) [7 marks]

List types of Microphone. State its Characteristics and explain Wireless Microphone in detail.

Solution

Types of Microphones:
- Dynamic, Condenser, Carbon, Ribbon, Crystal/Piezoelectric, Electret, MEMS.

Characteristics: Sensitivity, Frequency Response, Directional Pattern, Impedance, Signal-to-Noise Ratio.

Wireless Microphone System:

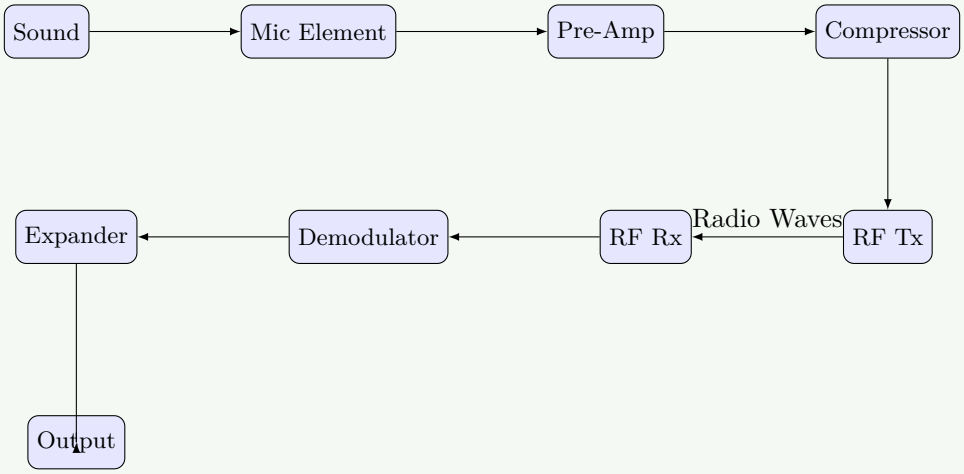

Figure 2. Wireless Mic System

- **Mic Element**: Converts sound to electrical signals.
- **Transmitter**: Modulates audio onto VHF/UHF carrier (FM/Digital).
- **Receiver**: Captures RF signal and demodulates audio.
- **Compander**: Compresses signal at Tx and expands at Rx for noise reduction.

Mnemonic

"WIRED: Wireless Is Radio-Enabled Device"

Question 1(c) OR [7 marks]

State characteristics of Loudspeakers and explain pearmeant magnet loudspeaker with its advantages and disadvantages.

Solution

Loudspeaker Characteristics:
- Frequency Response, Sensitivity, Impedance, Power Handling, Directivity, Distortion.

Permanent Magnet Loudspeaker:

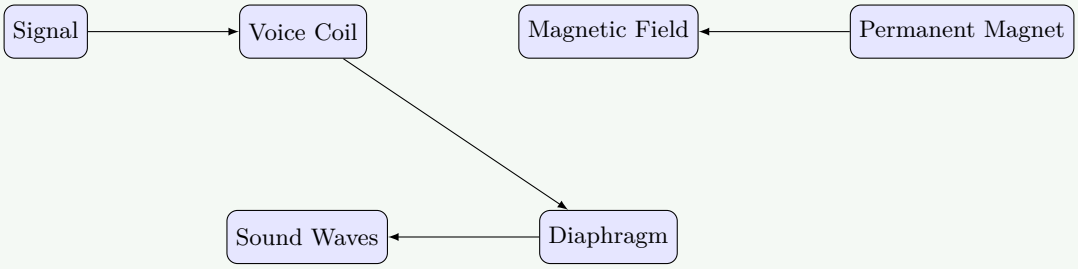

Figure 3. PM Loudspeaker Principle

Advantages: Cost-effective, Reliable, Compact, Efficient.
Disadvantages: Limited Power (fixed field), Magnet Deterioration, Weight, Heat Sensitivity.

Mnemonic

"PMLS: Permanent Magnet Loudly Speaks"

Question 2(a) [3 marks]

Define 1. Aspect ratio 2. Chrominance 3. Additive Mixing

Solution

Term	Definition
Aspect Ratio	Ratio of width to height of a display screen (e.g., 16:9)
Chrominance	Color information in video signal, separate from brightness (Luminance)
Additive Mixing	Combining colored lights (RGB) to create new colors; all together make white

Mnemonic

"ACA: Aspect sets dimensions, Chrominance adds color, Additive mixing creates brightness"

Question 2(b) [4 marks]

Explain interlace scanning

Solution

Concept: Dividing a video frame into two fields (odd and even lines) to reduce bandwidth. Use standard rate 50/60 fields/sec.

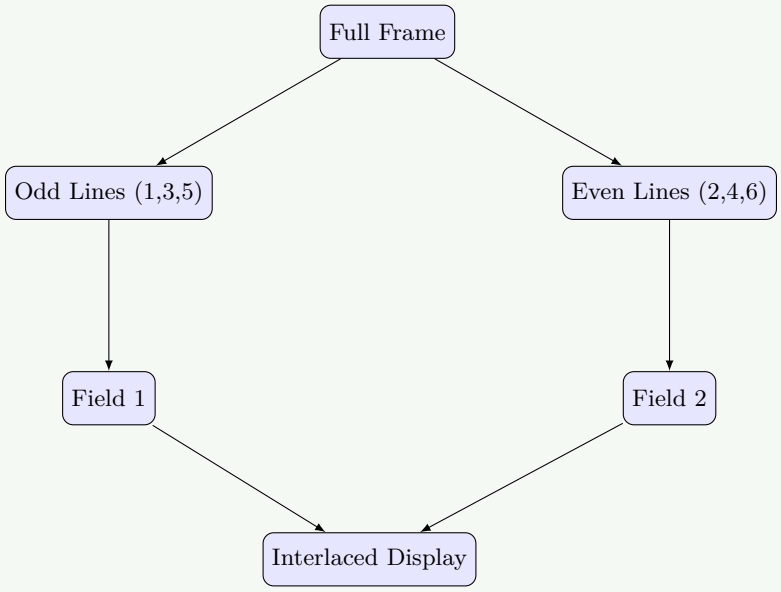

Figure 4. Interlaced Scanning Process

Mnemonic

"ODD-EVEN: One Display, then Delayed Extra Visual Enhancement Next"

Question 2(c) [7 marks]

Discuss working principle of LED Television. State its advantages and compare it with LCD television.

Solution

Working Principle: LED TV is an LCD TV that uses LEDs for backlighting instead of CCFLs.

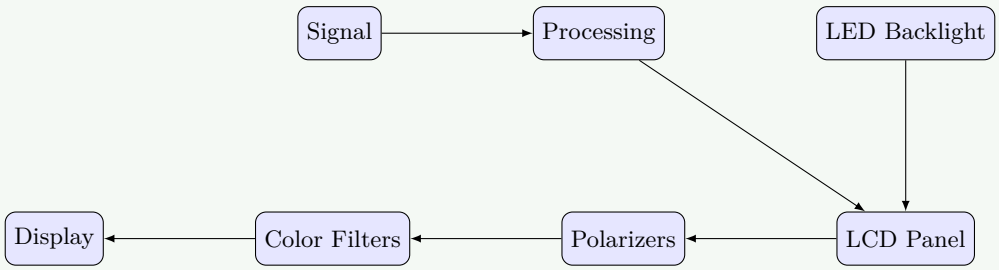

Figure 5. LED TV Architecture

Advantages: Energy Efficient, Thinner Design, Better Contrast (Local Dimming), Longer Lifespan, Mercury-free.

Comparison (LED vs LCD):

Feature	LED TV	LCD TV
Backlight	LEDs	CCFL Tubes
Thickness	Thinner (Slim)	Thicker
Power	Lower	Higher
Contrast	Better	Lower

Mnemonic

"LEDGE: Light Emitting Diodes Give Excellence"

Question 2(a) OR [3 marks]

State any six standards of Color television system.

Solution

- **PAL** (Phase Alternating Line)
- **NTSC** (National Television System Committee)
- **SECAM** (Sequential Color with Memory)
- **PAL-M** (Brazil variant)
- **ATSC** (Digital - N. America)
- **DVB-T** (Digital - Europe)
- **ISDB** (Digital - Japan)

Mnemonic

"PANS-ADI: PAL, ATSC, NTSC, SECAM - All Display Images"

Question 2(b) OR [4 marks]

Explain working of LCD Television.

Solution

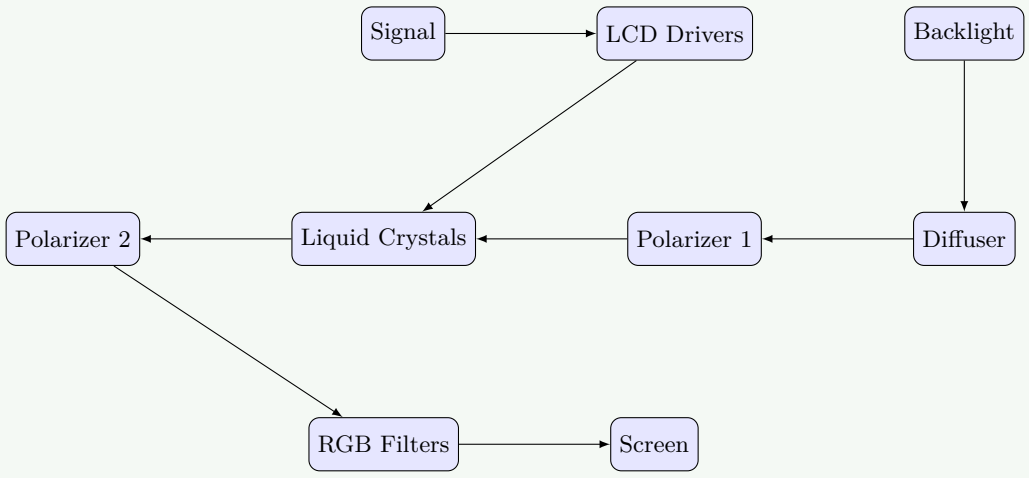

Figure 6. LCD TV Stack

Working: Backlight passes through Polarizer 1. Liquid crystals twist/untwist based on voltage (TFT) to block or pass light through Polarizer 2. Light then passes through RGB filters to create color pixels.

Mnemonic

"BPLTC: Backlight Passes through Liquid crystals That Color"

Question 2(c) OR [7 marks]

Draw and Explain block diagram of PAL-D decoder.

Solution

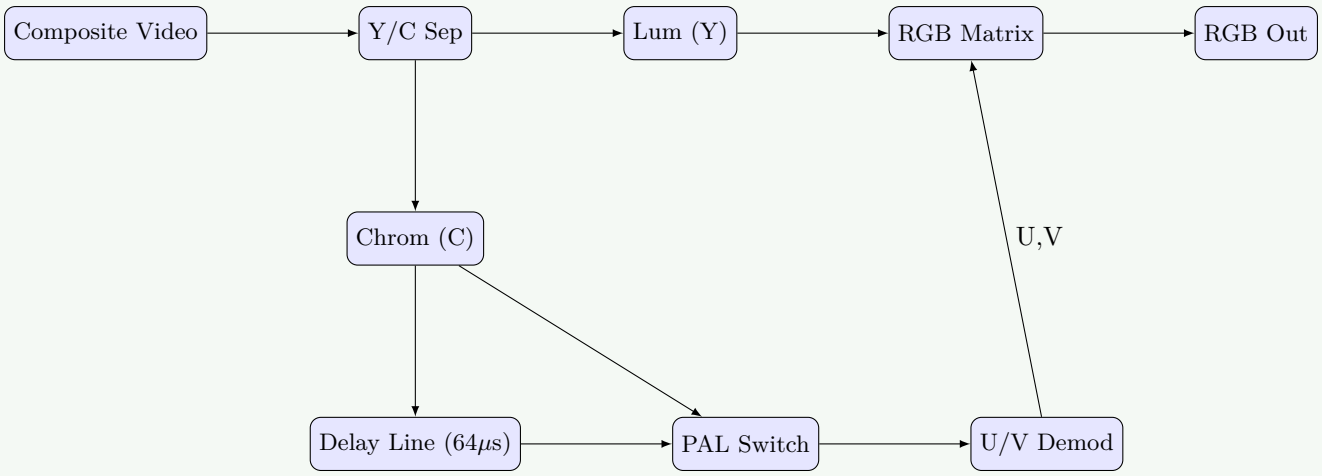

Figure 7. PAL-D Decoder Block Diagram

- **Y/C Separator**: Splits brightness (Y) and color (C).
- **Delay Line**: Delays signal by 64μs (one line) to average phase errors.
- **PAL Switch**: Reverses V-signal phase on alternate lines.
- **U/V Demodulator**: Extracts color difference signals.
- **RGB Matrix**: Combines Y, U, V to output Red, Green, Blue.

Mnemonic

"PAL Decodes Color Right By Switching, Delaying, Unscrambling Variations"

Question 3(a) [3 marks]

Give classification of rooftop Solar power plant and explain any one plant.

Solution

Classification:

- **Grid-Connected/On-Grid**: Connected directly to utility grid without batteries.
- **Off-Grid/Standalone**: Uses batteries to store power, not connected to grid.
- **Hybrid**: Combines both grid connection and battery backup.

Grid-Connected System:

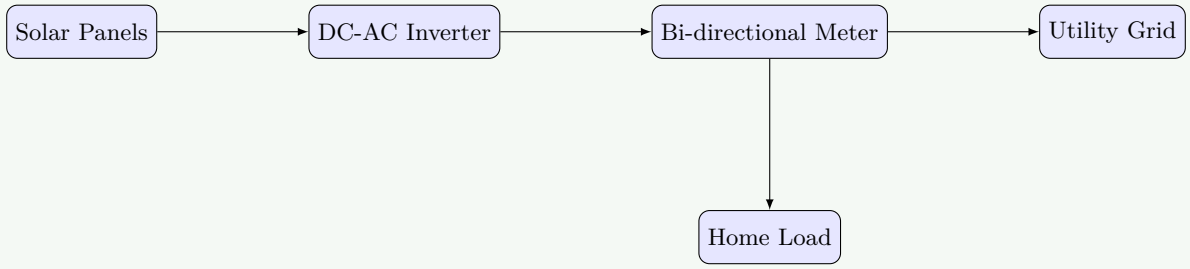

Figure 8. Grid-Connected Rooftop System

- Solar panels generate DC power from sunlight.
- Inverter converts DC to AC synchronous with grid.
- Bi-directional meter records import (consumption) and export (generation).
- Excess power is fed to the grid (net metering).

Mnemonic

"GOH: Grid connects, Off-grid stores, Hybrid does both"

Question 3(b) [4 marks]

Give at least four technical specification of Refrigerator and split Air condition each.

Solution

Refrigerator Specifications:

Specification	Typical Range
Capacity	150-750 liters
Power Consumption	100-400 kWh/year
Refrigerant	R-600a, R-134a
Compressor	Reciprocating or Inverter

Split Air Conditioner Specifications:

Specification	Typical Range
Cooling Capacity	1.0 - 2.0 Tons (12000-24000 BTU)
ISEER Rating	3.0 - 5.0 Stars
Refrigerant	R-32, R-410A
Noise Level	30-45 dB (Indoor unit)

Mnemonic

"CERT: Capacity, Efficiency, Refrigerant Type, Temperature"

Question 3(c) [7 marks]

Explain working of Microwave oven with respect to its working principle, functional block diagram and its safety precautions while in operative condition.

Solution

Working Principle: The magnetron generates high-frequency microwaves (2.45 GHz) which agitate water molecules in food. This vibration creates friction, generating heat that cooks the food from within.

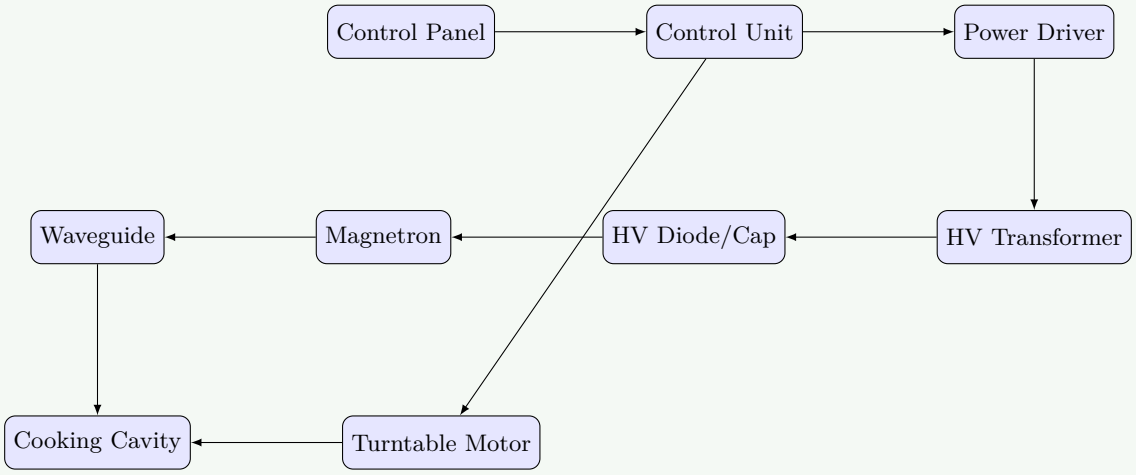

Figure 9. Microwave Oven Block Diagram

Safety Precautions:

- **Door Interlocks**: Ensure oven cannot operate if door is open.
- **RF Shielding**: Metal mesh on door prevents microwave leakage.
- **Capacitor Discharge**: High voltage capacitor retains charge; needs discharge during service.
- **No Metal**: Do not use metal containers inside to prevent arcing.
- **Never Run Empty**: Can damage magnetron due to reflected waves.

Mnemonic

"MICROWAVE: Magnetron Initiates Cooking, Radiation Only Within Authorized Vessel Environment"

Question 3(a) OR [3 marks]

State various hardware used in rooftop solar power plant and explain solar panels used in it.

Solution

Hardware: Solar Panels, Inverter, Mounting Structure, Batteries (optional), Charge Controller, AC/DC Distribution Boxes, Cables.

Solar Panels Explanation:

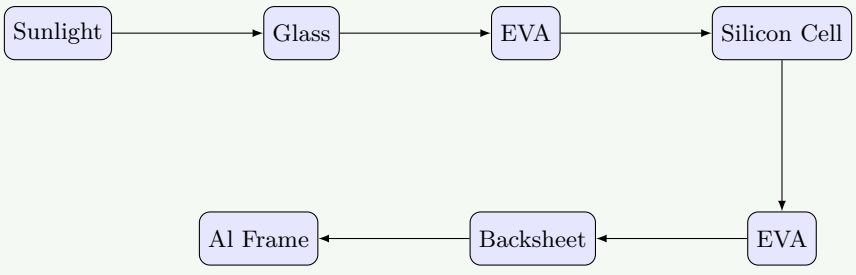

Figure 10. Solar Panel Layers

Solar PV panels consist of semiconductor cells (Silicon) encapsulated between glass and backsheet. They convert photon energy into DC electrical energy via photovoltaic effect. Types: Monocrystalline (high eff), Polycrystalline (lower cost).

Mnemonic

"SIMPLE: Solar panels Integrate Multiple Photovoltaic Layers Efficiently"

Question 3(b) OR [4 marks]

Give at least four technical specification of Microwave oven and washing machine each.

Solution

Microwave Oven:
- Power Output: 700 - 1200 Watts
- Frequency: 2.45 GHz
- Capacity: 20 - 32 Liters
- Control: Digital/Touchpad/Knob

Washing Machine:
- Capacity: 6 kg - 10 kg
- Spin Speed: 800 - 1400 RPM
- Type: Top Load / Front Load
- Energy Rating: 5 Star

Mnemonic

"CPFWS: Capacity, Power, Frequency, Washing technology, Spin speed"

Question 3(c) OR [7 marks]

Give classification of washing machine. Explain working of top load washing machine with respect to its functional block diagram and working strategy/steps to wash clothes.

Solution

Classification: By loading (Top/Front), By automation (Semi/Fully), By technology (Agitator/Impeller).
Functional Block Diagram (Top Load):

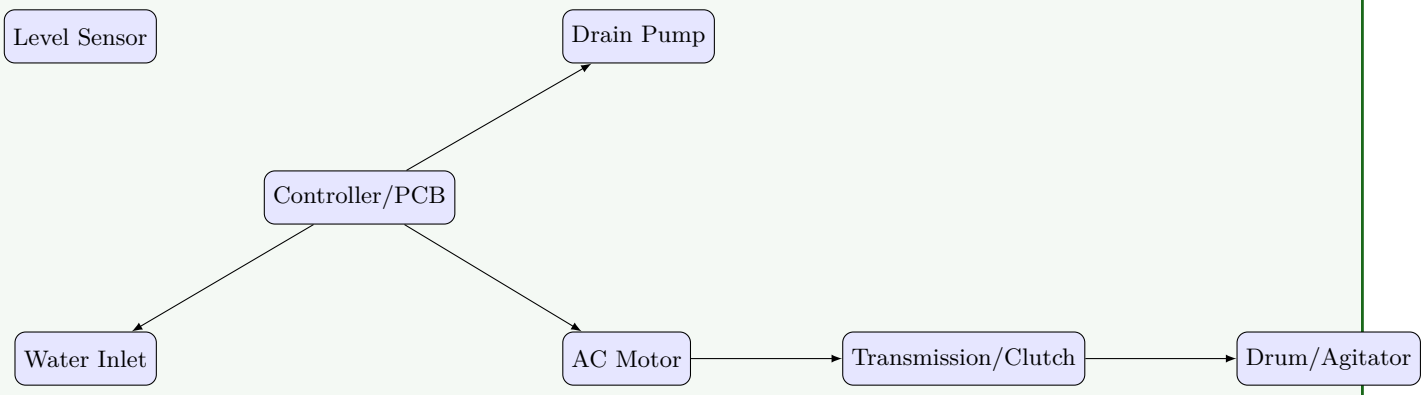

Figure 11. Washing Machine Blocks

Working Steps:
- **Fill**: Water valve opens, fills tub to set level.
- **Wash**: Motor rotates agitator back and forth to clean clothes.

- **Drain**: Pump removes dirty water.
- **Rinse**: Clean water fills, agitates to remove soap, then drains.
- **Spin**: Drum spins at high speed to extract water centrifugally.

Mnemonic

"FWDRS: Fill, Wash, Drain, Rinse, Spin"

Question 4(a) [3 marks]

Explain working principle of laser printer. Give its technical specifications.

Solution

Working Principle: Laser printers use the xerographic principle. A laser beam scans back and forth across a rotating drum, creating a static electricity pattern (latent image). The drum attracts toner powder to these charged areas. The toner is then transferred to paper and fused with heat and pressure.

Technical Specifications:

Specification	Typical Range
Resolution	600 - 1200 DPI
Print Speed	20 - 50 PPM
Memory	64 MB - 512 MB
Duty Cycle	10,000 - 100,000 pages/month

Mnemonic

"RSCDCP: Resolution, Speed, Cycle, Duty, Connectivity, Power"

Question 4(b) [4 marks]

Explain working principle of Photo copier machine. State its technical specifications.

Solution

Working Principle: Photocopiers use electrophotography (Xerography). Light reflected from the document discharges a charged drum in light areas, leaving a charge image in dark areas (text). Toner sticks to charged areas and transfers to paper.

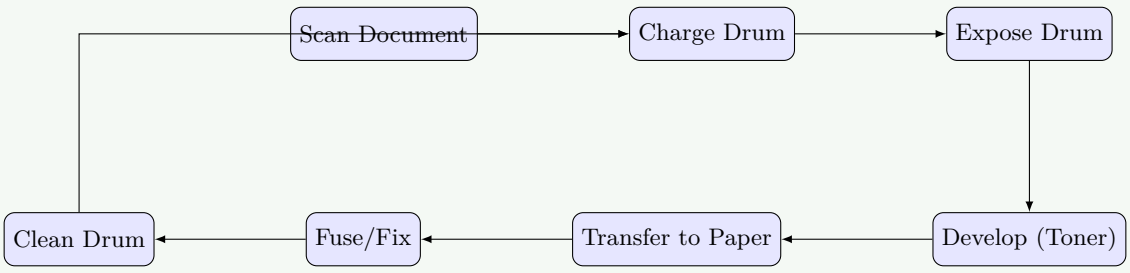

Figure 12. Photocopy Process Cycle

Specifications: Copy Speed (20-60 CPM), Zoom (25-400%), Resolution (600 DPI), Paper Size (A5-A3), Warm-up time (<30s).

Mnemonic

"CRSPWMP: Copy speed, Resolution, Size, Paper capacity, Warm-up, Multiple copy, Power"

Question 4(c) [7 marks]

Draw and explain schematic of wireless CCTV camera system. Explain Network video recorder. State types of camera used in CCTV system and explain any one of them.

Solution

Wireless CCTV Schematic:

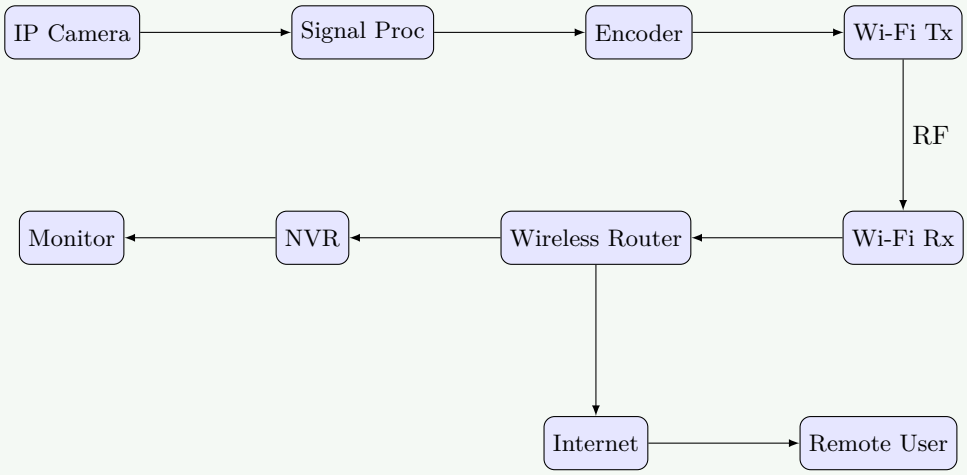

Figure 13. Wireless CCTV System

NVR (Network Video Recorder): Records digital streams from IP cameras over network. Features: Remote access, high resolution support, intelligent analytics, storage management.
Camera Types: Dome, Bullet, PTZ, Box, Thermal, 360-Fisheye.
IP Camera: Connects to network, has own IP address, processes images digitally, supports PoE, higher resolution than analog.

Mnemonic

"WISP-NET: Wireless Images Securely Processed, Networked, Enabling Tracking"

Question 4(a) OR [3 marks]

Explain working principle of inkjet printer. Give its technical specifications.

Solution

Working Principle: Propels tiny droplets of liquid ink onto paper.

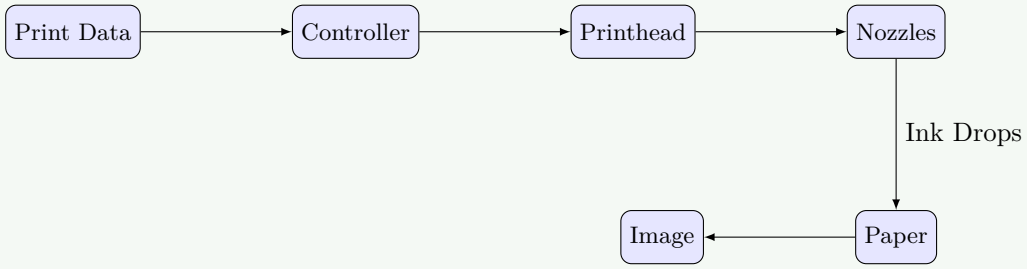

Figure 14. Inkjet Printing Process

Includes thermal bubble or piezoelectric technology to eject ink.
Specifications: Resolution (4800 DPI), Speed (10-20 PPM), Ink (Dye/Pigment), Connectivity (USB/Wi-Fi).

Mnemonic

"RIPS-CCD: Resolution, Ink type, Print speed, Size of droplet, Connectivity, Capacity, Droplet"

Question 4(b) OR [4 marks]

Explain maintenance and trouble shooting of television receiver and Washing machine.

Solution

Television Maintenance:
- Clean screen with microfiber cloth.
- Ensure proper ventilation to prevent overheating.
- Check cable connections periodically.

Troubleshooting: No power? Check fuse/cable. No sound? Check mute/speakers. Poor picture? Adjust antenna/settings.

Washing Machine Maintenance:
- Clean lint filter and door seal regularly.
- Descale drum to remove limescale.
- Keep door open after use to prevent mold.

Troubleshooting: Not draining? Check pump filter. Leaking? Check hoses. Vibration? Level the feet.

Mnemonic

"CREST: Clean Regularly, Examine connections, Service filters, Test functions"

Question 4(c) OR [7 marks]

Define CCTV. Explain with schematic CCTV camera system installed in a home. Describe analog camera, Digital camera and IP camera and differentiate them.

Solution

CCTV: Closed-Circuit Television, a system where video is transmitted to a limited set of monitors for surveillance.
Home System Schematic:

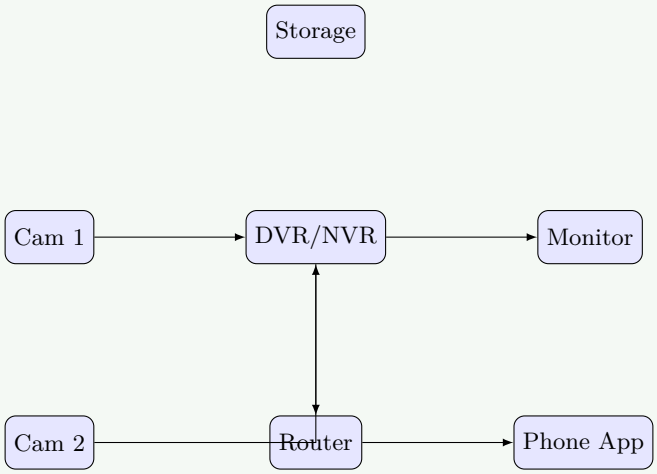

Figure 15. Home CCTV Layout

Feature	Analog	Digital (HD-TVI)	IP Camera
Signal	Analog (Coax)	Digital via Coax	Digital (Ethernet)
Resolution	SD (Low)	HD (Medium)	UHD (High)
Cabling	Coax (RG59)	Coax	Cat5e/Cat6
Intelligent	No	Limited	Advanced Analytics

Mnemonic

"ADI: Analog uses Decaying technology, IP represents Innovation"

Question 5(a) [3 marks]

Define maintenance. State its types. Explain any one of them.

Solution

Maintenance: Process of preserving equipment in good working order to prevent failure.
Types: Preventive, Predictive, Corrective (Breakdown), Condition-based.
Preventive Maintenance: Scheduled servicing performed at regular intervals (regardless of condition) to prevent unexpected failures. Example: Weekly cleaning, monthly oiling.

Mnemonic

"PPCR: Prevent Problems through Checkups Regularly"

Question 5(b) [4 marks]

Explaining maintenance of PA systems and Home theatre system.

Solution

PA System Maintenance:

- **Cables**: Check for cuts/loose connectors. Coil properly.
- **Mics**: Clean grills, check for moisture damage.
- **Amps**: Clean vents to prevent overheating.

Home Theatre Maintenance:

- **Dusting**: Accumulation causes heat/static.
- **Ventilation**: Ensure receivers have airflow.
- **Connections**: Re-plug HDMI/Audio cables to remove oxidation.
- **Calibration**: Re-run auto-setup periodically.

Mnemonic

"CAVS: Clean, Adjust, Verify connections, Service regularly"

Question 5(c) [7 marks]

Draw and Explain block diagram of DTH technology. Discuss hardware components used in DTH system. Discuss various modern features currently provided in current DTH system.

Solution

DTH Block Diagram:

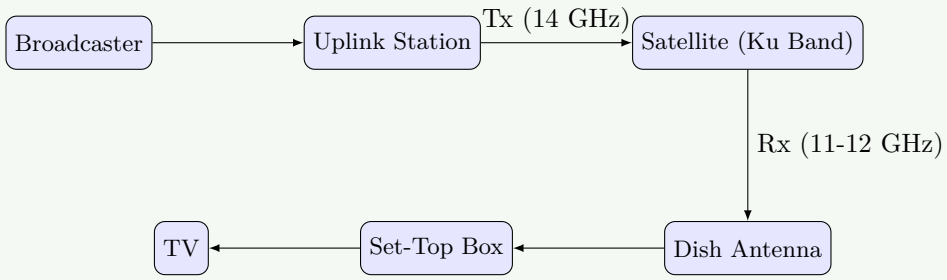

Figure 16. DTH Transmission System

Hardware: Dish Antenna (Parabolic reflector), LNB (Low Noise Block downconverter), Coaxial Cable, Set-Top Box (Decoder + Smart Card), Remote.
Features: HD/4K support, Recording (DVR), Pause/Rewind Live TV, Interactive Apps, Video on Demand.

Mnemonic

"DISH-STB: Direct Information Satellite Hub - Signals Transmitted to Box"

Question 5(a) OR [3 marks]

Differentiate between predictive and preventive maintenance.

Solution

Aspect	Preventive	Predictive
Basis	Time/Schedule	Actual Condition
Trigger	Fixed Interval	Data/Warning Signs
Cost	Medium (may replace good parts)	Low long-term (max life)
Example	Change oil every 5000km	Change oil when sensor detects dirt

Mnemonic

"TIME vs DATA: Timed Intervals Maintenance Everywhere vs Data Analysis Triggers Action"

Question 5(b) OR [4 marks]

Describe troubleshooting procedure and safety precautions for microwave oven.

Solution

Troubleshooting Procedure:

1. **No Power**: Check fuse, thermal cutout, door switches.
2. **Not Heating**: Check magnetron, HV diode, HV capacitor.
3. **Sparks/Arcing**: Check waveguide cover, remove metal objects, check paint damage.

Safety Precautions:

- Always discharge HV capacitor before touching components (store 2000V+).
- Check for radiation leakage after reassembly.
- Never bypass door interlock switches.
- Do not operate with door open.

Mnemonic

"DUEL-SAFE: Disconnect power, Use discharge tool, Examine systematically, Look for damage - Safety Always First, Every time"

Question 5(c) OR [7 marks]

Draw and explain block diagram of PA system. Discuss design parameters while designing for auditorium. Draw connection diagram of four 8 Ohm speakers to PA system amplifier having 8 Ohm as output impedance.

Solution

PA System Block Diagram:

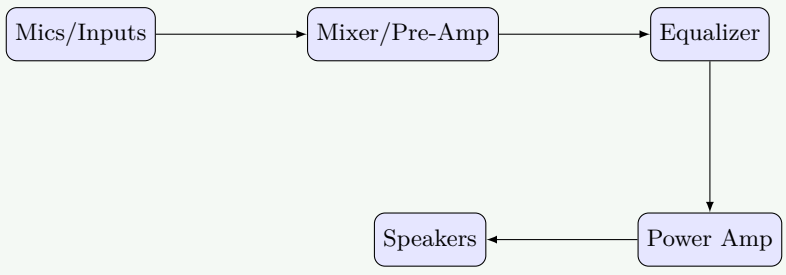

Figure 17. Public Address System

Auditorium Design Parameters: Acoustics (Reverb time), Coverage (Speaker placement), Intelligibility (STI), Power (Watts per seat), Feedback control.
Speaker Connection (Series-Parallel): Target: 8Ω total load from four 8Ω speakers.

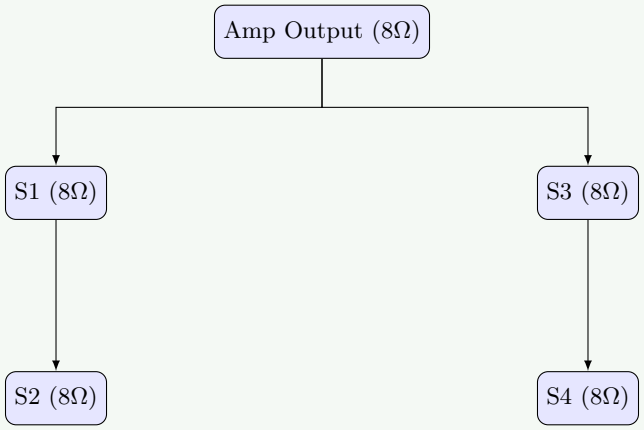

Figure 18. Series-Parallel: (8+8) || (8+8) = 16 || 16 = 8Ω

Connect pair 1 in series ($8+8=16\Omega$). Connect pair 2 in series ($8+8=16\Omega$). Connect these two pairs in parallel ($16||16=8\Omega$). Matches amp impedance perfectly.

Mnemonic

"PASS: Proper Amplification, Speaker placement, Series-parallel wiring"