

# Consumer Electronics and Maintenance (4341107) - Summer 2023 Solution

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## Question 1(a) [3 marks]

Describe maintenance procedure of CCTV.

### Solution

**Table 1.** CCTV Maintenance Procedure

Step	Procedure	Details
1	<b>Camera Cleaning</b>	Clean lenses and housings monthly
2	<b>Cable Inspection</b>	Check for damage/exposure quarterly
3	<b>Recording Check</b>	Verify data storage and playback monthly
4	<b>Firmware Updates</b>	Update software when available
5	<b>Angle Adjustment</b>	Realign cameras as needed

### Mnemonic

“CCRU: Clean, Check, Record, Update”

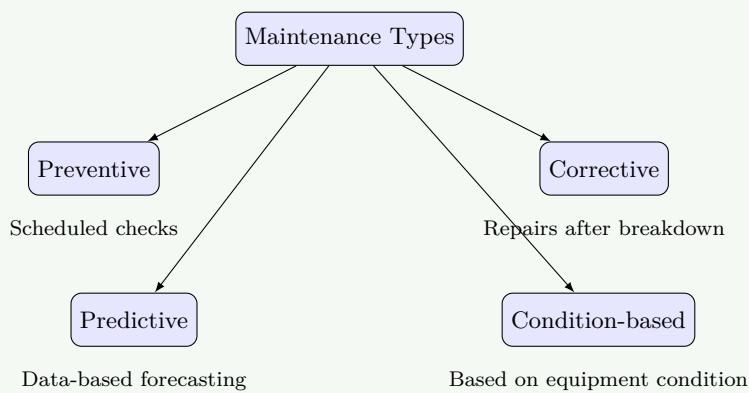
## Question 1(b) [4 marks]

List the types of maintenance and explain in brief.

### Solution

**Table:** Types of Maintenance

Type	Description	When Performed	Benefits
<b>Preventive</b>	Regular checks before failure	Scheduled intervals	Reduces unexpected downtime
<b>Corrective</b>	Repairs after equipment breaks	After failure occurs	Restores functionality
<b>Predictive</b>	Uses data to predict failures	Based on analysis	Optimizes maintenance timing
<b>Condition-based</b>	Monitors actual equipment state	When conditions indicate	Reduces unnecessary maintenance

**Figure 1.** Types of Maintenance**Mnemonic**

“PCPC: Prevent, Correct, Predict, Condition”

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

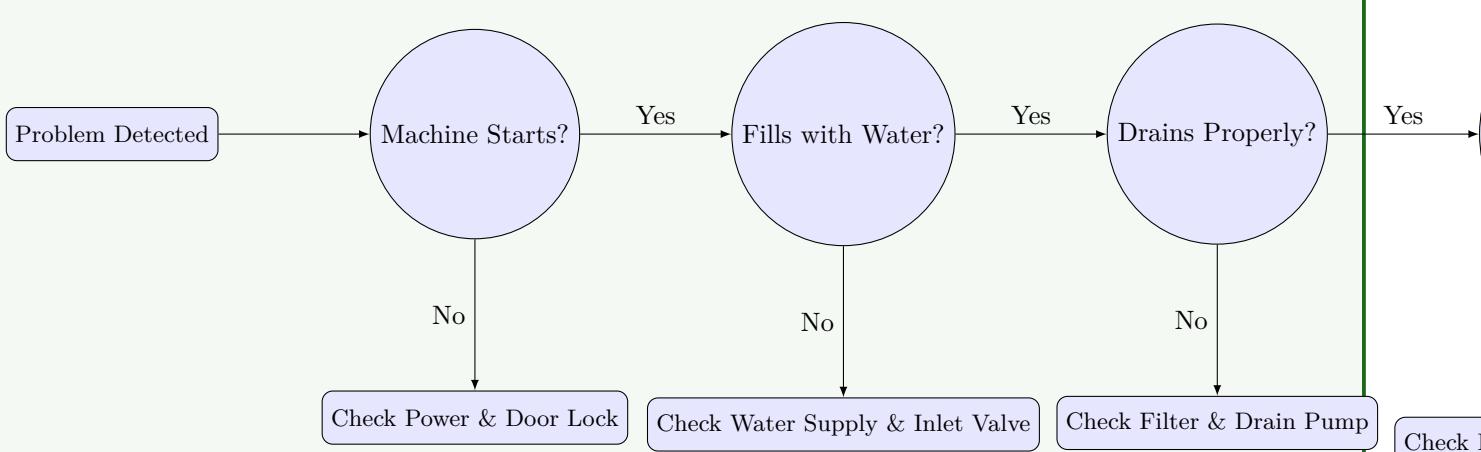
Explain maintenance and troubleshooting procedure of Washing Machine.

**Solution****Table: Washing Machine Maintenance and Troubleshooting**

Problem	Possible Cause	Troubleshooting Steps
Machine not starting	Power issue, door lock	Check power supply, ensure door is closed properly
Not filling with water	Water supply, inlet valve	Check water taps, inspect inlet hoses for blocks
Not draining	Clogged filter, drain pump	Clean filter, check drain hose for kinks
Excessive vibration	Unbalanced load, shipping bolts	Redistribute clothes, check if shipping bolts removed
Leaking water	Damaged hoses, loose connections	Inspect and tighten connections, replace damaged hoses

**Regular Maintenance:**

- **Monthly:** Clean detergent drawer and door seal
- **Quarterly:** Run empty hot cycle with vinegar/cleaner
- **Bi-annually:** Check hoses for cracks, clean filter

**Figure 2.** Washing Machine Troubleshooting**Mnemonic**

"POWER: Power, Observe, Water, Examine, Repair"

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

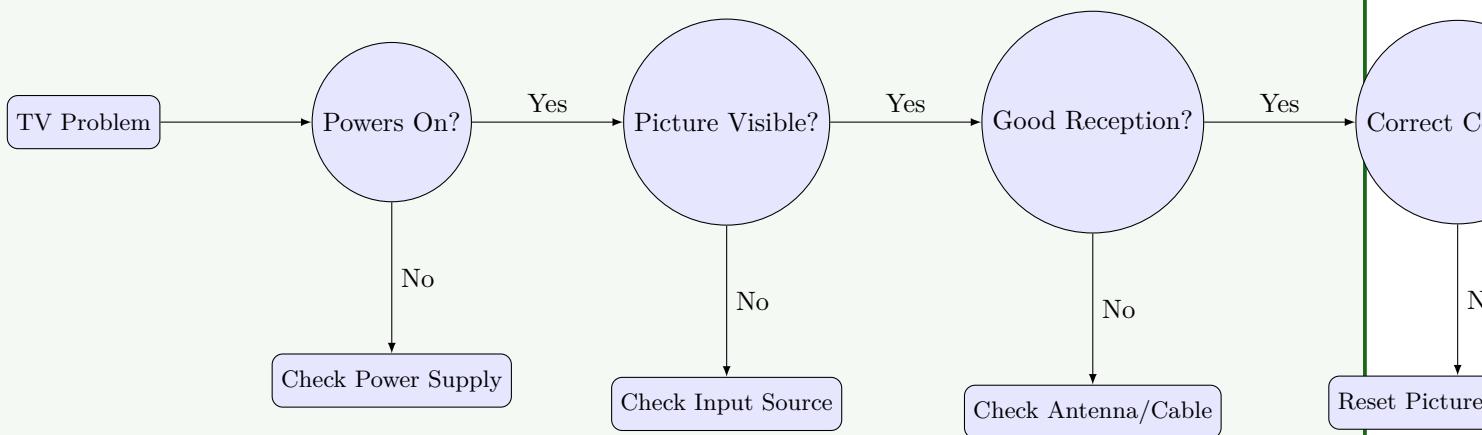
Explain maintenance and troubleshooting procedure of Digital TV.

**Solution****Table: Digital TV Maintenance and Troubleshooting**

Problem	Possible Cause	Troubleshooting Steps
No power	Power supply issue	Check power cord, wall outlet, try different socket
No picture	Input/source selection	Verify correct input selected, check source device
Poor reception	Antenna/cable issue	Check cable connections, reposition antenna
Distorted colors	Display settings	Reset picture settings to default
Remote not working	Battery issue, sensor blocked	Replace batteries, ensure IR sensor not blocked

**Regular Maintenance:**

- **Weekly:** Dust screen carefully with microfiber cloth
- **Monthly:** Check and tighten cable connections
- **Annually:** Update firmware if available

**Figure 3.** TV Troubleshooting Flowchart**Mnemonic**

“SPIRE: Supply, Picture, Input, Reception, Electronics”

**Question 2(a) [3 marks]**

**Define:** (1) Brightness (2) Luminance (3) Chrominance

**Solution****Table: Key TV Display Terms**

Term	Definition	Measured In
<b>Brightness</b>	Perceived intensity of light output from display	Subjective perception (nits)
<b>Luminance</b>	Objective measurement of light intensity per unit area	Candela per square meter ( $\text{cd}/\text{m}^2$ )
<b>Chrominance</b>	Color information in video signal independent of brightness	U and V components

**Mnemonic**

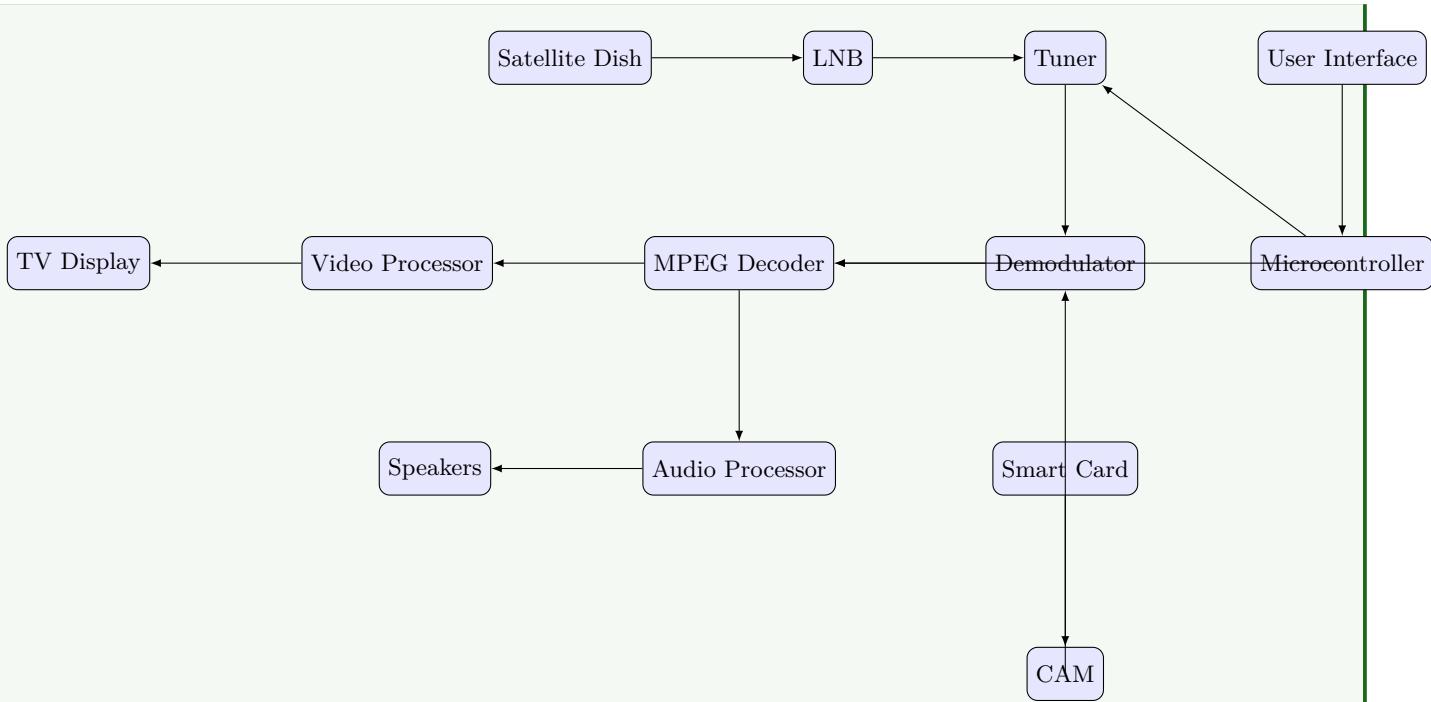
“BLC: Brightness is Light perception, Luminance is Calculated light, Chrominance is Color information”

**Question 2(b) [4 marks]**

Draw and explain block diagram of DTH receiver.

**Solution**

**DTH Receiver Block Diagram:**

**Figure 4.** DTH Receiver**Table: DTH Receiver Components**

Component	Function
<b>Satellite Dish</b>	Receives satellite signals from space
<b>LNB (Low Noise Block)</b>	Converts high-frequency signals to lower frequency
<b>Tuner</b>	Selects specific channel frequency
<b>Demodulator</b>	Extracts digital data from carrier signal
<b>MPEG Decoder</b>	Decompresses audio/video data
<b>Conditional Access Module</b>	Controls subscription access

**Mnemonic**

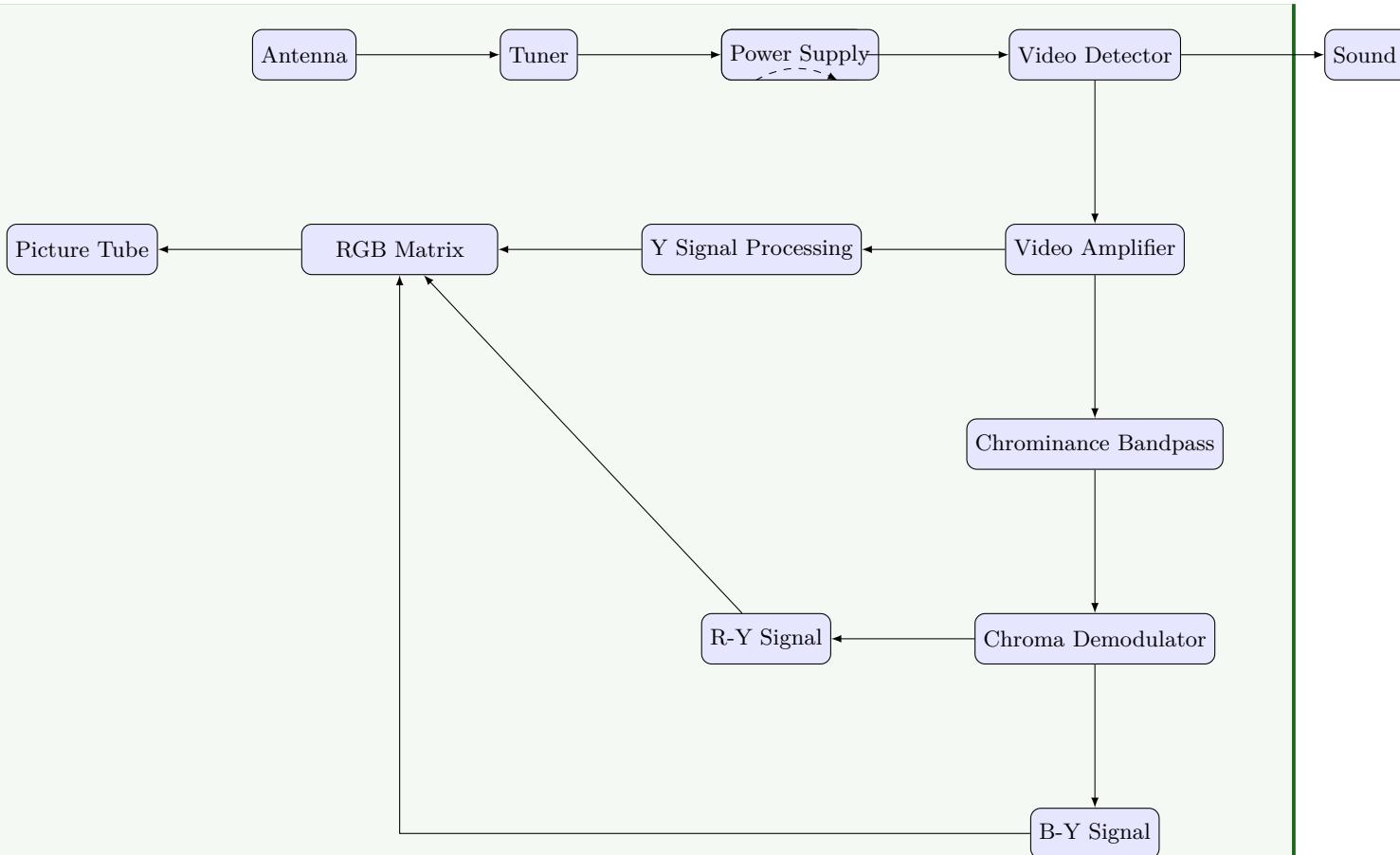
"SLTDM: Satellite captures, LNB converts, Tuner selects, Demodulator extracts, MPEG decodes"

**Question 2(c) [7 marks]**

Draw and explain block diagram of colour TV receiver.

**Solution**

Colour TV Receiver Block Diagram:



**Figure 5.** Colour TV Receiver

**Table: Colour TV Components and Functions**

Section	Function	Key Components
<b>Tuner</b>	Selects desired channel	RF amplifier, mixer, local oscillator
<b>IF Amplifier</b>	Amplifies intermediate frequency	Bandpass filters, amplifiers
<b>Video Detector</b>	Extracts video signal	Diode detector, filters
<b>Chrominance Section</b>	Processes color information	Bandpass filter, color demodulator
<b>Luminance Section</b>	Processes brightness information	Y signal amplifier
<b>RGB Matrix</b>	Combines signals for display	Mixing circuits
<b>Audio Section</b>	Processes sound	Sound IF, detector, amplifier

## Mnemonic

“TIVACRL: Tuner tunes, IF amplifies, Video detects, Audio separates, Chrominance demodulates, RGB mixes, Light displays”

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

**Write a short note on LED TV.**

**Solution****Table: LED TV Technology**

Aspect	Description
Basic Technology	Uses Light Emitting Diodes for display backlighting
Types	Edge-lit (LEDs at edges), Direct-lit (LEDs behind screen), Full-array (with local dimming)
Advantages	Thinner profile, energy efficient, better contrast ratio, longer lifespan than LCD
Display Panel	Still uses LCD panel; LEDs are only for backlighting

**Mnemonic**

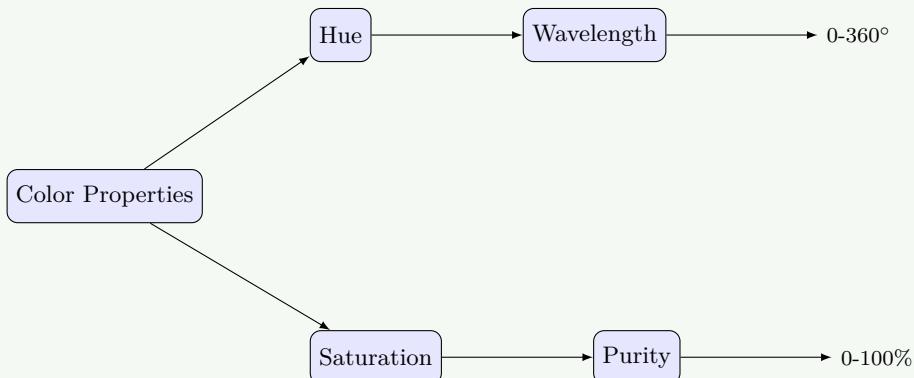
“BEST: Backlighting with LEDs, Energy efficient, Slim design, True colors”

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

Briefly explain the terms: (1) Hue (2) Saturation

**Solution****Table: Color Properties**

Term	Definition	Range	Example
Hue	Actual color wavelength (red, blue, green, etc.)	0-360 degrees on color wheel	Red=0°, Green=120°, Blue=240°
Saturation	Intensity or purity of color (how vivid)	0-100% (gray to pure color)	0% = grayscale, 100% = vivid color

**Figure 6.** Color Hue and Saturation**Mnemonic**

“HS: Hue is the color Shade, Saturation is the color Strength”

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

Explain additive colour mixing using colour circle diagram and Grassman's law.

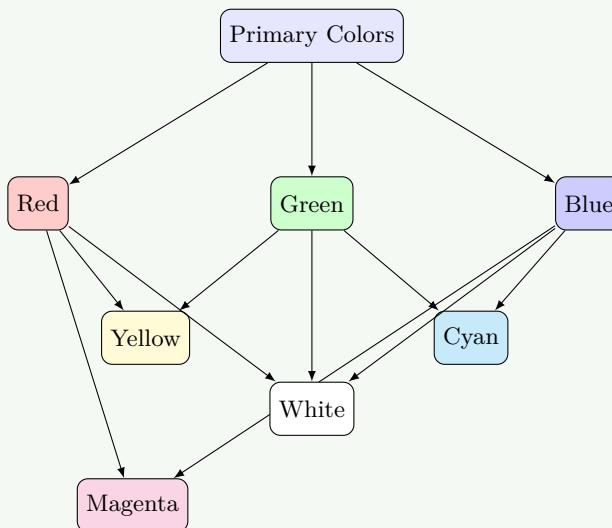
## Solution

**Table: Additive Color Mixing Principles**

Color Combination	Result	RGB Value
Red + Green	Yellow	(255,255,0)
Green + Blue	Cyan	(0,255,255)
Blue + Red	Magenta	(255,0,255)
Red + Green + Blue	White	(255,255,255)
No colors	Black	(0,0,0)

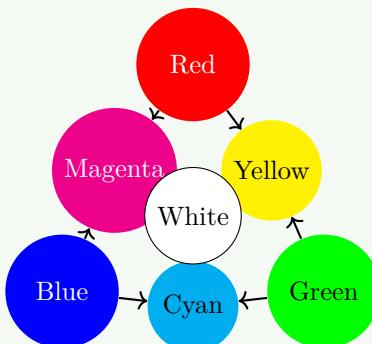
**Grassman's Laws:**

- Law 1: Any color can be created by mixing three primary colors
- Law 2: The appearance of a color depends only on its tristimulus values
- Law 3: In additive mixing, the tristimulus values add together



**Figure 7.** Additive Mixing Flow

**Color Circle Diagram:**



**Figure 8.** Color Mixing Circle

### Mnemonic

"RGB-CMY-W: Red, Green, Blue make Cyan, Magenta, Yellow, and White"

## Question 3(a) [3 marks]

List wiring and safety instructions for microwave oven.

### Solution

**Table: Microwave Oven Wiring and Safety Instructions**

Category	Instructions
<b>Wiring</b>	Use grounded outlet with dedicated 15-20A circuit
<b>Power</b>	Ensure voltage matches rating (typically 220-240V)
<b>Installation</b>	Allow 5cm clearance on all sides for ventilation
<b>Safety</b>	Never operate empty, never bypass door interlocks
<b>Maintenance</b>	Disconnect power before servicing, discharge capacitor

### Mnemonic

“POWER: Proper Outlet, Wiring check, Empty operation avoided, Repairs by professionals”

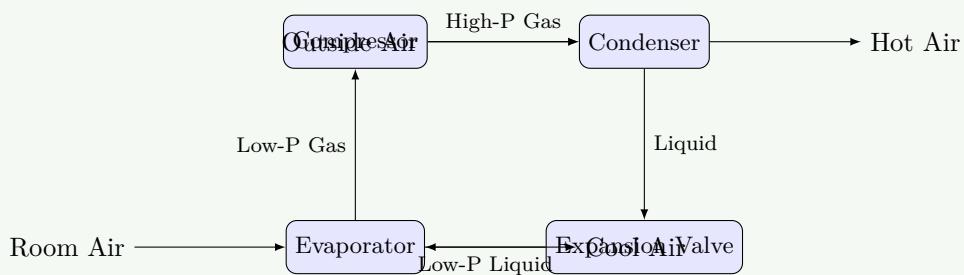
## Question 3(b) [4 marks]

Explain working of Air conditioner.

### Solution

**Table: Air Conditioner Working Cycle**

Component	Function	Process
<b>Compressor</b>	Pressurizes refrigerant	Converts low-pressure gas to high-pressure gas
<b>Condenser</b>	Releases heat outside	Converts gas to liquid, expels heat
<b>Expansion Valve</b>	Regulates refrigerant flow	Reduces pressure of liquid
<b>Evaporator</b>	Absorbs heat from room	Converts liquid to gas, cools air
<b>Thermostat</b>	Controls temperature	Regulates compressor operation



**Figure 9. Air Conditioner Cycle**

### Mnemonic

“CELT: Compress gas, Expel heat, Lower pressure, Take in heat”

## Question 3(c) [7 marks]

Explain electronic controller for washing machine and fuzzy logic washing machine. Also list technical specifications of washing machine.

### Solution

**Table: Electronic Controller in Washing Machines**

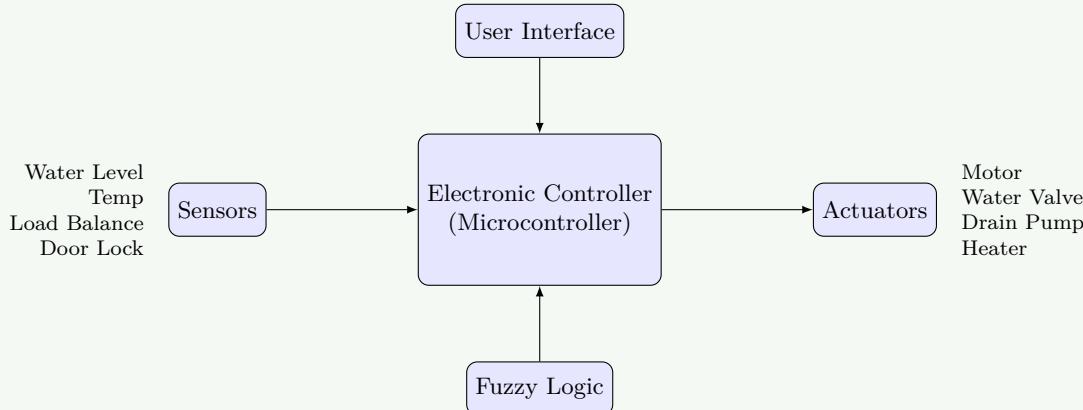
Component	Function
Microcontroller	Central processing unit controlling all operations
Sensors	Detect water level, temperature, load balance, door status
Input Interface	Buttons/touch panel for program selection
Display	Shows program status, time remaining, error codes
Actuator Drivers	Control motor, valves, heater, pump

#### Fuzzy Logic in Washing Machines:

- Uses artificial intelligence for optimal washing
- Adjusts water level, wash time, and spin speed based on load
- Makes decisions using approximate reasoning instead of precise values
- Adapts to different fabric types and soil levels automatically

#### Technical Specifications:

- **Capacity:** 6-10 kg (front load), 5-8 kg (top load)
- **Energy Rating:** A+++ to B (EU standards)
- **Water Consumption:** 40-70 liters per cycle
- **Spin Speed:** 800-1600 RPM
- **Cycle Options:** 8-16 programs



**Figure 10.** Washing Machine Controller

#### Mnemonic

“SCRAM: Sensors detect, Controller processes, Rules applied, Actuators operate, Machine adapts”

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

State main components of solar power system and specifications of solar power system.

### Solution

**Table: Solar Power System Components**

Component	Function
Solar Panels	Convert sunlight to DC electricity
Inverter	Converts DC to AC power
Battery Bank	Stores energy for later use
Charge Controller	Prevents battery overcharging
Mounting Structure	Supports and angles panels optimally

**Specifications:**

- **Panel Capacity:** 250-400 Watts per panel
- **System Size:** 1-10 kW (residential)
- **Battery Capacity:** 100-200 Ah
- **Inverter Efficiency:** 90-97%
- **Expected Lifespan:** 25-30 years (panels)

**Mnemonic**

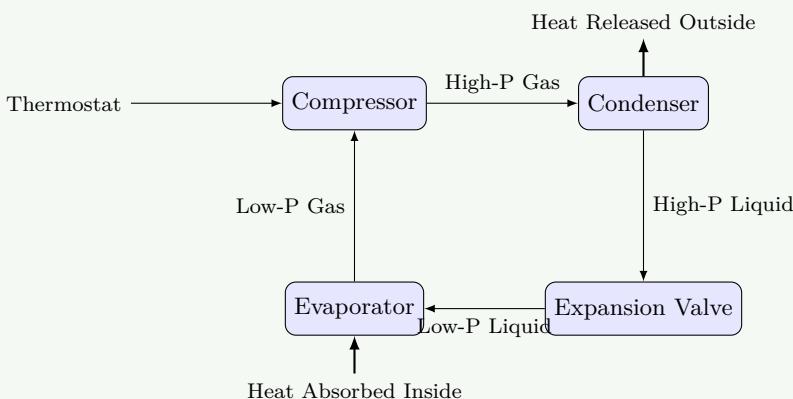
“PIBCM: Panels collect, Inverter converts, Batteries store, Controller protects, Mounts support”

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

Explain working of Refrigerator.

**Solution****Table: Refrigerator Working Cycle**

Stage	Process	Component	State of Refrigerant
1	Compression	Compressor	Low pressure gas → High pressure gas
2	Condensation	Condenser coils	High pressure gas → High pressure liquid
3	Expansion	Expansion valve	High pressure liquid → Low pressure liquid
4	Evaporation	Evaporator coils	Low pressure liquid → Low pressure gas

**Figure 11.** Refrigerator Cycle**Mnemonic**

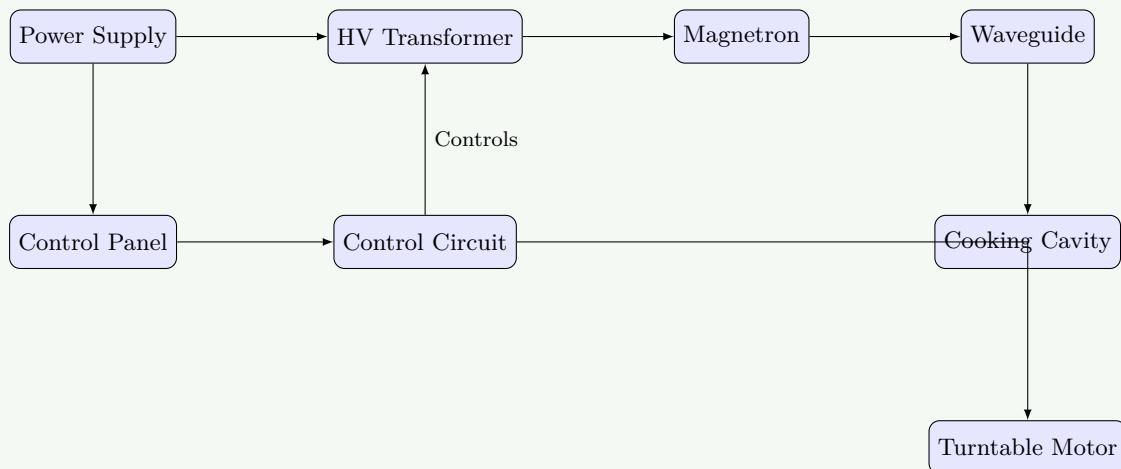
“CEHE: Compress gas, Expel heat, Halve pressure, Extract heat”

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

Draw and explain block diagram of Microwave oven. List types, applications and technical specifications of microwave oven.

#### Solution

##### Microwave Oven Block Diagram:



**Figure 12.** Microwave Oven Block Diagram

#### Types of Microwave Ovens:

- Solo: Basic heating and defrosting only
- Grill: Has additional grilling element
- Convection: Combines microwave with convection heating
- Over-the-Range (OTR): Includes ventilation system
- Built-in: Designed for cabinet installation

#### Applications:

- Cooking: Fast meal preparation
- Reheating: Leftover foods
- Defrosting: Frozen foods
- Sterilization: Small items
- Commercial: Food service industry

#### Technical Specifications:

- Capacity: 20-40 liters
- Power Output: 700-1200 watts
- Power Consumption: 1100-1500 watts
- Frequency: 2.45 GHz
- Voltage: 220-240V AC

#### Mnemonic

“MICROWAVES: Magnetron generates, Interior receives, Control regulates, Rotating turntable, Oven cavity, Waveguide directs, Alternating current powers, Ventilation cools, Electronic timer, Safety interlocks”

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

List specifications of MF printer and LCD projector.

### Solution

**Table: Multi-Function Printer Specifications**

Specification	Typical Range
<b>Print Resolution</b>	600-4800 dpi
<b>Print Speed</b>	20-40 ppm (black), 15-30 ppm (color)
<b>Scan Resolution</b>	600-1200 dpi
<b>Connectivity</b>	Wi-Fi, Ethernet, USB, Cloud
<b>Paper Capacity</b>	100-500 sheets

**Table: LCD Projector Specifications**

Specification	Typical Range
<b>Brightness</b>	2000-5000 lumens
<b>Resolution</b>	XGA ( $1024 \times 768$ ) to 4K ( $3840 \times 2160$ )
<b>Contrast Ratio</b>	2000:1 to 100,000:1
<b>Lamp Life</b>	4000-8000 hours
<b>Connectivity</b>	HDMI, VGA, USB, Wireless

### Mnemonic

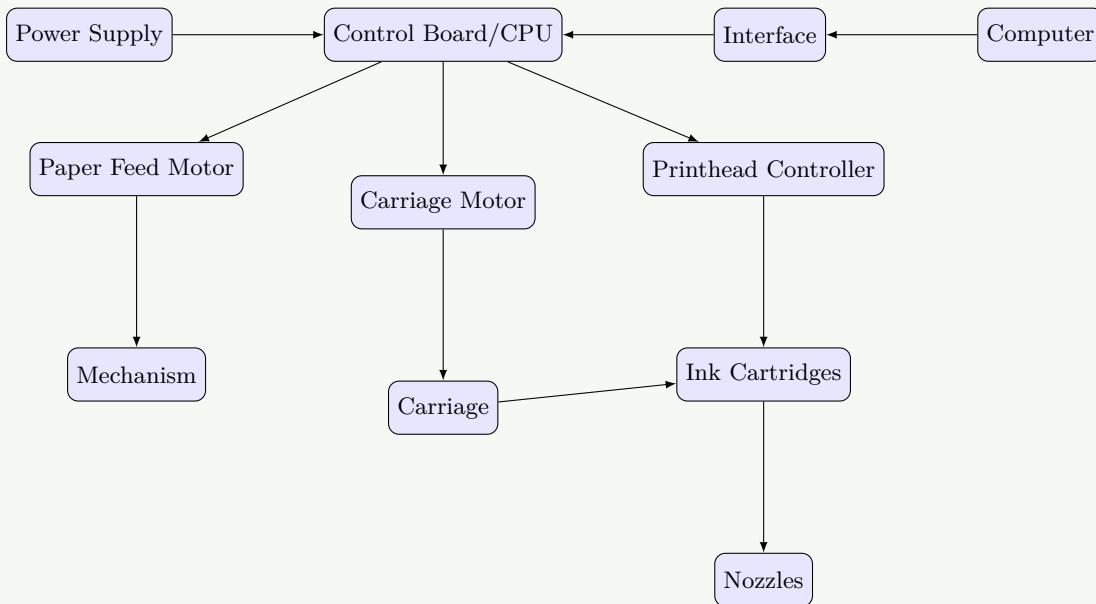
“PSCPL: Print resolution, Speed, Connectivity, Projection brightness, Lamp life”

## Question 4(b) [4 marks]

Draw block diagram of Inkjet printer and explain its working in brief.

### Solution

**Inkjet Printer Block Diagram:**



**Figure 13.** Inkjet Printer

### Working of Inkjet Printer:

- Document Processing:** Control board receives data and converts to printer commands
- Paper Loading:** Feed motor pulls paper from tray

3. **Printing:** Printhead moves across paper while ejecting tiny ink droplets
4. **Droplet Formation:** Thermal or piezoelectric method forces ink droplets onto paper
5. **Paper Advancement:** Paper advances line by line until printing completes

#### Mnemonic

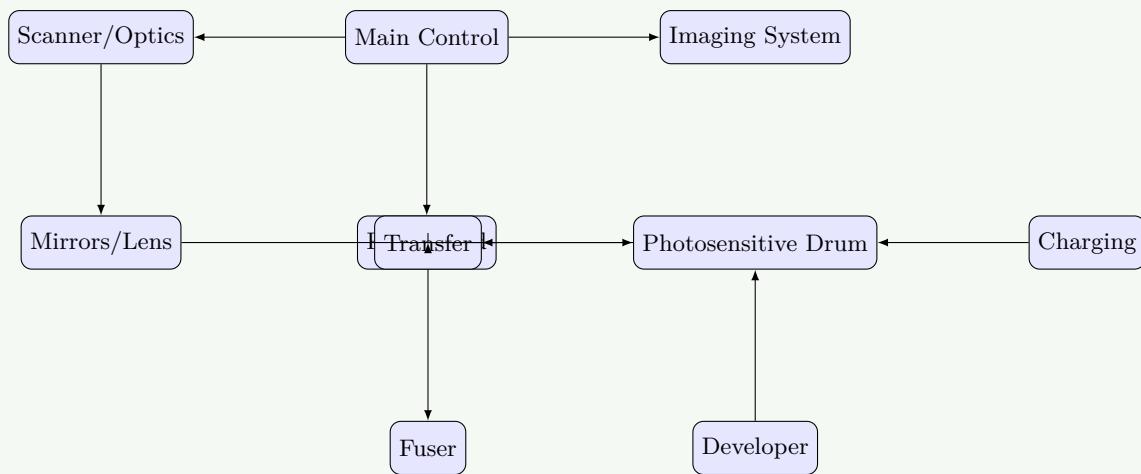
“PIPES: Paper feeds, Ink ejects, Printhead moves, Electronic control, Sheet advances”

## Question 4(c) [7 marks]

Explain working of Photocopier with block diagram and list its specifications.

#### Solution

##### Photocopier Block Diagram:



**Figure 14.** Photocopier System

##### Working of Photocopier:

1. **Charging:** Photosensitive drum receives uniform electrostatic charge
2. **Exposure:** Original document scanned, creating light pattern on drum
3. **Developing:** Toner particles attracted to charged areas on drum
4. **Transfer:** Toner image transferred from drum to paper
5. **Fusing:** Heat and pressure melt toner permanently onto paper
6. **Cleaning:** Drum cleaned for next cycle

##### Technical Specifications:

- **Speed:** 20-60 pages per minute
- **Resolution:** 600-1200 dpi
- **Paper Capacity:** 250-2000 sheets
- **Maximum Paper Size:** A3/11×17 inches
- **Zoom Range:** 25-400%
- **Memory:** 512MB-2GB
- **Connectivity:** Ethernet, USB, Wi-Fi

#### Mnemonic

“CETFC: Charge drum, Expose image, Transfer toner, Fuse permanently, Clean drum”

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

Write a short note on CCTV.

### Solution

**Table: CCTV System Overview**

Aspect	Description
<b>Full Form</b>	Closed-Circuit Television
<b>Purpose</b>	Security monitoring and surveillance
<b>Components</b>	Cameras, DVR/NVR, monitors, cables, power supply
<b>Types</b>	Analog, IP (digital), Wireless, HD-CVI/TVI/SDI
<b>Features</b>	Motion detection, night vision, remote viewing

**Key Applications:**

- Security monitoring of buildings
- Traffic monitoring
- Retail loss prevention
- Public area surveillance
- Home security

### Mnemonic

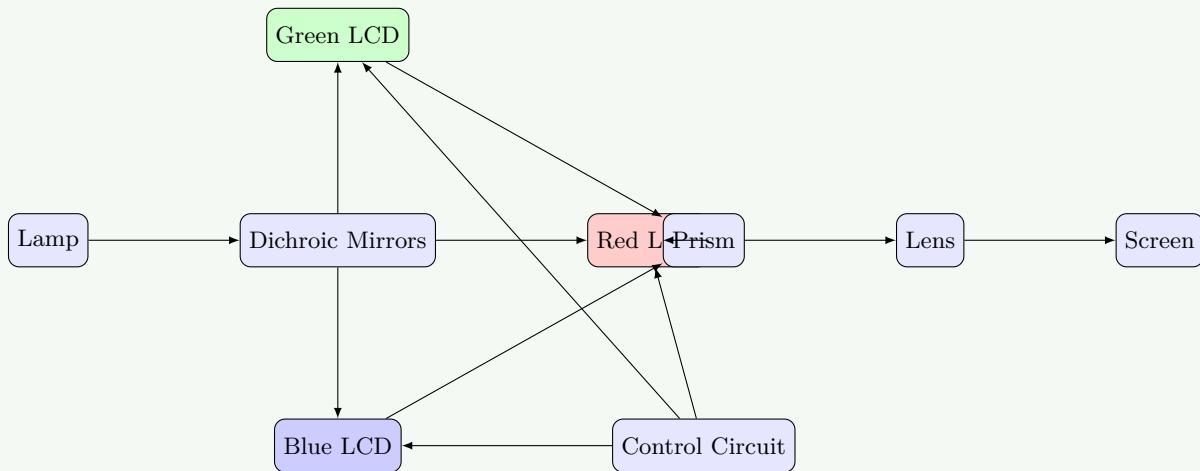
“SCRAM: Security monitoring, Closed circuit, Recording footage, Access restricted, Monitoring continuous”

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

Explain working of LCD projector with block diagram.

### Solution

**LCD Projector Block Diagram:**



**Figure 15. LCD Projector**

**Working of LCD Projector:**

1. **Light Generation:** High-intensity lamp produces white light
2. **Color Separation:** Dichroic mirrors split light into RGB components
3. **Image Formation:** LCD panels modulate light based on input signal
4. **Recombination:** Prism combines RGB images into full-color image

5. **Projection:** Lens system projects final image onto screen

#### Mnemonic

“LSCIP: Light source generates, Split into colors, Control with LCDs, Image combined, Projected on screen”

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

Explain working of laser printer with block diagram.

#### Solution

##### Laser Printer Block Diagram:

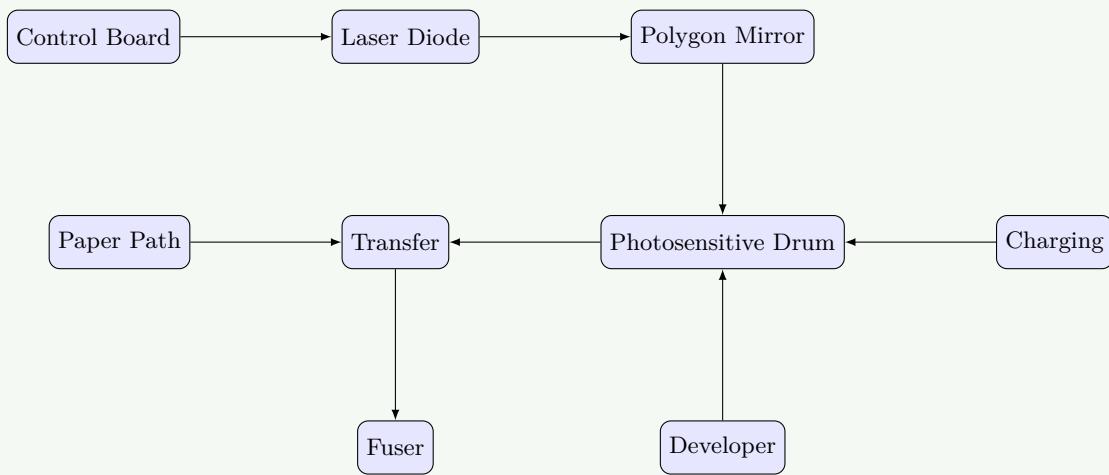


Figure 16. Laser Printer

##### Laser Printing Process: Table: Six Steps of Laser Printing

Step	Process	Component	Function
1	Cleaning	Cleaning blade	Removes residual toner from drum
2	Charging	Primary corona	Applies uniform negative charge to drum
3	Writing	Laser & mirror	Creates electrostatic image on drum
4	Developing	Developer unit	Applies toner to charged areas of drum
5	Transferring	Transfer corona	Moves toner from drum to paper
6	Fusing	Fuser unit	Melts toner permanently onto paper

##### Technical Specifications:

- Print Speed: 20-50 ppm
- Resolution: 600-2400 dpi
- Memory: 128MB-1GB
- Duty Cycle: 10,000-150,000 pages/month
- Connectivity: USB, Ethernet, Wi-Fi

#### Mnemonic

“CCWDTF: Clean drum, Charge uniformly, Write with laser, Develop with toner, Transfer to paper, Fuse permanently”

## Question 5(a) [3 marks]

Define: (1) Pitch (2) Reverberation (3) Microphone.

### Solution

**Table: Audio Terminology**

Term	Definition	Measured In
Pitch	Perceived frequency of sound; how high or low a tone seems	Hertz (Hz)
Reverberation	Persistence of sound after source stops; caused by reflections	Seconds (RT60)
Microphone	Transducer that converts sound waves into electrical signals	Sensitivity in dB/mV/Pa

### Mnemonic

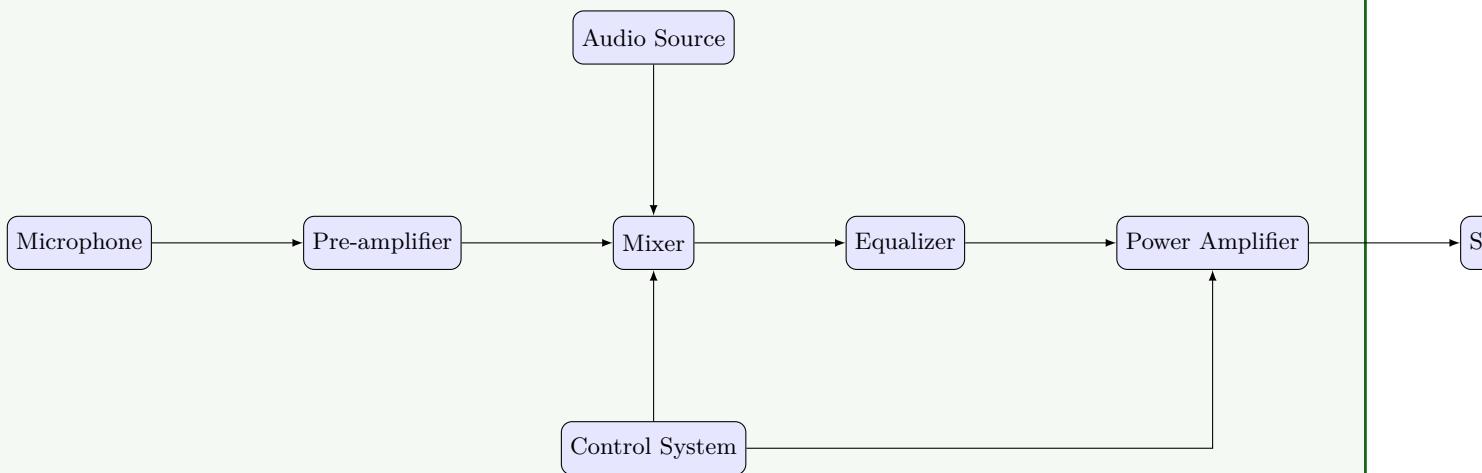
“PRM: Pitch is frequency, Reverberation is reflection, Microphone is converter”

## Question 5(b) [4 marks]

Draw and explain block diagram of PA system.

### Solution

**PA System Block Diagram:**



**Figure 17.** Public Address System

**Table: PA System Components**

Component	Function
Microphone	Captures sound and converts to electrical signals
Pre-amplifier	Boosts weak microphone signals to line level
Mixer	Combines multiple audio sources, adjusts levels
Equalizer	Adjusts frequency response for optimal sound
Power Amplifier	Increases signal strength to drive speakers
Speaker System	Converts electrical signals back to sound waves

**Mnemonic**

"MPMEPA: Microphone Picks, Preamp Magnifies, Equalizer adjusts, Power Amplifier drives, Audience hears"

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

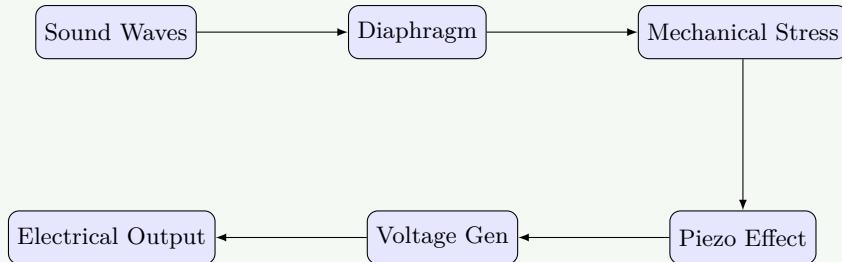
Explain Crystal microphone.

**Solution**

**Table: Crystal Microphone Characteristics**

Characteristic	Description
<b>Operating Principle</b>	Piezoelectric effect
<b>Construction</b>	Crystal element (Rochelle salt) between metal plates
<b>Response</b>	High output, moderate frequency response
<b>Impedance</b>	Very high (typically $> 1 \text{ M}\Omega$ )
<b>Durability</b>	Sensitive to heat and humidity

**Working Principle:** When sound waves strike the diaphragm, they create pressure on the crystal element. Due to the piezoelectric effect, the crystal generates a voltage proportional to the mechanical stress. This voltage is the electrical representation of the sound.



**Figure 18.** Crystal Microphone Working

**Applications:**

- Telephone receivers
- Contact pickups for acoustic instruments
- Low-cost recording devices
- Public address systems

**Advantages and Limitations: Table: Pros and Cons**

Advantages	Limitations
High output voltage	Poor frequency response
No external power needed	Sensitive to temperature/humidity
Simple construction	Higher distortion
Low cost	Fragile crystal element

**Mnemonic**

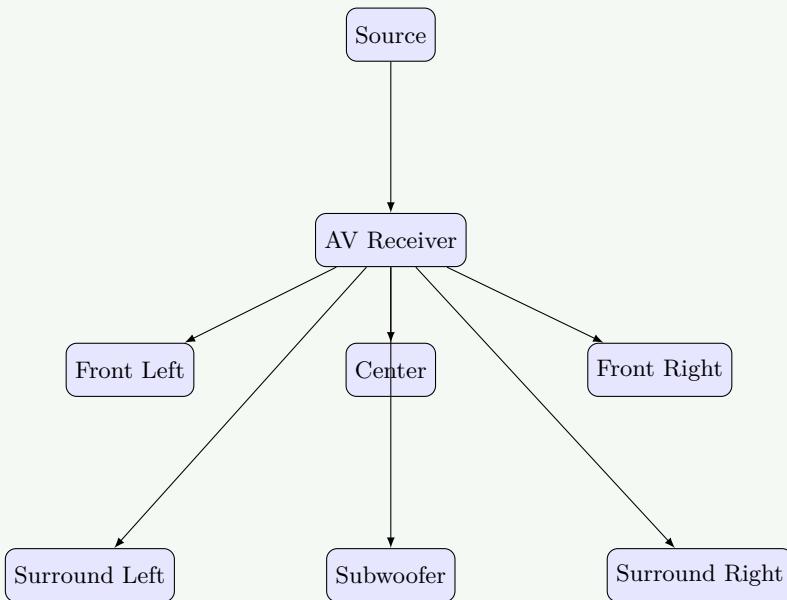
"PIES: Pressure applied, Impedance high, Electricity generated, Sound converted"

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

Draw block diagram of Home theatre sound system.

### Solution

**Home Theatre Sound System Block Diagram:**



**Figure 19.** 5.1 Home Theatre System

### Mnemonic

"SAVS: Source provides, Amplifier processes, Various speakers deliver, Surround experience created"

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

Explain optical sound recording.

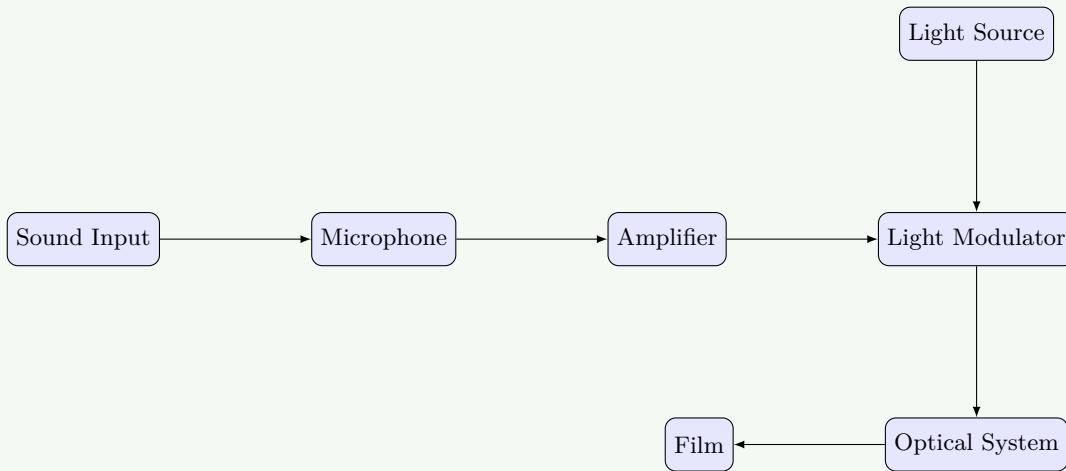
### Solution

**Table: Optical Sound Recording Process**

Step	Process	Component
1	<b>Sound Capture</b>	Microphone converts sound to electrical signals
2	<b>Modulation</b>	Signal modulates light source intensity or area
3	<b>Exposure</b>	Modulated light exposes photographic film
4	<b>Development</b>	Film processed to create visible sound track
5	<b>Playback</b>	Light passes through track, photodetector converts to electrical signal

#### Types of Optical Sound Tracks:

- **Variable Density:** Light intensity varies (darker/lighter areas)
- **Variable Area:** Transparent area width varies against opaque background

**Figure 20.** Optical Recording**Mnemonic**

“CAREP: Capture sound, Amplify signal, Record optically, Expose film, Play back”

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

Define loudspeaker. List types of loudspeakers and explain working of any one type of loudspeaker.

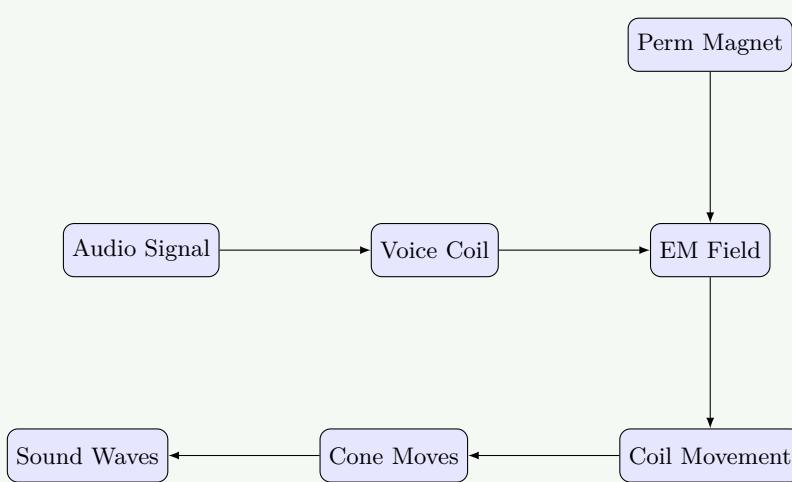
**Solution**

**Definition:** A loudspeaker is an electroacoustic transducer that converts electrical signals into sound waves by moving a diaphragm that creates air pressure variations.

**Table: Types of Loudspeakers**

Type	Working Principle	Frequency Range	Applications
Dynamic/Moving Coil	Electromagnetic induction	20Hz-20kHz	Most common, general purpose
Electrostatic	Electrostatic force between plates	100Hz-20kHz	High-fidelity audio systems
Piezoelectric	Piezoelectric effect	1kHz-25kHz	Tweeters, alarms, buzzers
Ribbon	Current through ribbon in magnetic field	2kHz-50kHz	High-frequency reproduction
Planar Magnetic	Magnetic force on conductor sheet	30Hz-20kHz	Audiophile headphones, speakers

**Working of Dynamic/Moving Coil Loudspeaker:**

**Figure 21.** Dynamic Loudspeaker working**Working Process:**

1. Audio current flows through voice coil
2. Current creates electromagnetic field
3. Electromagnetic field interacts with permanent magnet
4. Voice coil moves forward/backward based on signal polarity
5. Attached cone/diaphragm moves, creating air pressure variations
6. Air pressure variations propagate as sound waves

**Components:**

- **Cone/Diaphragm:** Moves air to create sound
- **Voice Coil:** Carries audio signal current
- **Magnet:** Creates static magnetic field
- **Suspension:** Keeps cone centered, allows movement
- **Frame/Basket:** Holds components in proper alignment

**Mnemonic**

“SEPVADICS: Signal Enters, Produces Vibrations, Activates Diaphragm, In Coordination with Suspension”