

Subject Name Solutions

4341107 – Summer 2023

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

Describe maintenance procedure of CCTV.

Solution

Table 1: CCTV Maintenance Procedure

Step	Procedure	Details
1	Camera Cleaning	Clean lenses and housings monthly
2	Cable Inspection	Check for damage/exposure quarterly
3	Recording Check	Verify data storage and playback monthly
4	Firmware Updates	Update software when available
5	Angle Adjustment	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 2: Types of Maintenance

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

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph TD
    A[Maintenance Types] --> B[Preventive]
    A --> C[Corrective]
    A --> D[Predictive]
    A --> E[Condition-based]
    B --> F[Scheduled checks]
    C --> G[Repairs after breakdown]
    D --> H[Data-based forecasting]
    E --> I[Based on equipment condition]
{Highlighting}
{Shaded}
```

Mnemonic

“PCPC: Prevent, Correct, Predict, Condition”

Question 1(c) [7 marks]

Explain maintenance and troubleshooting procedure of Washing Machine.

Solution

Table 3: 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

```
flowchart LR
    A[Problem Detected] --> B{Machine Starts?}
    B -- No --> C[Check Power & Door Lock]
    B -- Yes --> D{Fills with Water?}
    D -- No --> E[Check Water Supply & Inlet Valve]
    D -- Yes --> F{Drains Properly?}
    F -- No --> G[Check Filter & Drain Pump]
    F -- Yes --> H{Excessive Vibration?}
    H -- Yes --> I[Check Load Balance & Shipping Bolts]
    H -- No --> J{Water Leakage?}
    J -- Yes --> K[Check Hoses & Connections]
```

Mnemonic

“POWER: Power, Observe, Water, Examine, Repair”

Question 1(c OR) [7 marks]

Explain maintenance and troubleshooting procedure of Digital TV.

Solution

Table 4: 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

```
flowchart LR
    A[TV Problem] --> B{Powers On?}
    B -- No --> C[Check Power Supply]
    B -- Yes --> D{Picture Visible?}
    D -- No --> E[Check Input Source]
    D -- Yes --> F{Good Reception?}
    F -- No --> G[Check Antenna/Cable]
    F -- Yes --> H{Correct Colors?}
    H -- No --> I[Reset Picture Settings]
    H -- Yes --> J{Remote Working?}
    J -- No --> K[Check Batteries/Sensor]
```

Mnemonic

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

Question 2(a) [3 marks]

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

Solution

Table 5: Key TV Display Terms

Term	Definition	Measured In
Brightness	Perceived intensity of light output from display	Subjective perception (nits)
Luminance	Objective measurement of light intensity per unit area	Candela per square meter (cd/m ²)
Chrominance	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:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph LR
    A[Satellite Dish] --> B[LNB]
    B --> C[Tuner]
    C --> D[Demodulator]
    D --> E[MPEG Decoder]
    E --> F[Video Processor]
    F --> G[Audio Processor]
    G --> H[TV Display]
```

```

G {-{-}{}} I[Speakers]
J[Smart Card] {-{-}{}} K[Conditional Access Module]
K {-{-}{}} D
L[User Interface] {-{-}{}} M[Microcontroller]
M {-{-}{}} C
M {-{-}{}} E
{Highlighting}
{Shaded}

```

Table 6: DTH Receiver Components

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

Mermaid Diagram (Code)

```

{Shaded}
{Highlighting} []
graph LR
    A[Antenna] {-{-}{}} B[Tuner]
    B {-{-}{}} C[IF Amplifier]
    C {-{-}{}} D[Video Detector]
    D {-{-}{}} E[Video Amplifier]
    D {-{-}{}} F[Sound IF \& Detector]
    E {-{-}{}} G[Y Signal Processing]
    E {-{-}{}} H[Chrominance Bandpass]
    H {-{-}{}} I[Chroma Demodulator]
    I {-{-}{}} J[R{-}Y Signal]
    I {-{-}{}} K[B{-}Y Signal]
    G {-{-}{}} L[RGB Matrix]
    J {-{-}{}} L
    K {-{-}{}} L
    L {-{-}{}} M[Picture Tube/Display]
    F {-{-}{}} N[Audio Amplifier]
    N {-{-}{}} O[Speaker]
    P[Power Supply] {-{-}{}} B
    P {-{-}{}} C
    P {-{-}{}} E
    P {-{-}{}} H
    P {-{-}{}} N
{Highlighting}
{Shaded}

```

Table 7: Colour TV Components and Functions

Section	Function	Key Components
Tuner	Selects desired channel	RF amplifier, mixer, local oscillator
IF Amplifier	Amplifies intermediate frequency	Bandpass filters, amplifiers
Video Detector	Extracts video signal	Diode detector, filters
Chrominance Section	Processes color information	Bandpass filter, color demodulator
Luminance Section	Processes brightness information	Y signal amplifier
RGB Matrix	Combines signals for display	Mixing circuits
Audio Section	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 8: 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 9: 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

Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Color Properties] --> B[Hue]  
    A --> C[Saturation]  
    B --> D[Wavelength of color]  
    C --> E[Purity/vividness]  
    D --> F[Measured in degrees on color wheel]  
    E --> G[Measured in percentage]  
{Highlighting}  
{Shaded}
```

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 10: 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

Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Additive Color Mixing] --> B[Primary Colors]  
    B --> C[Red]  
    B --> D[Green]  
    B --> E[Blue]  
    C --> F["Red + Green = Yellow"]  
    D --> F  
    D --> G["Green + Blue = Cyan"]  
    E --> G  
    E --> H["Blue + Red = Magenta"]  
    C --> H  
    C --> I["Red + Green + Blue = White"]  
    D --> I  
    E --> I  
{Highlighting}  
{Shaded}
```

Color Circle Diagram:

```
Yellow  
 /{}  
 / {}  
 / {}  
 Red {-{-}{-}{-}{-}{-}Green}  
 { /}  
 { /}  
 {/}  
 Magenta{-{-}{-}{-}Cyan}  
 { /}  
 { /}  
 {/}  
 Blue
```

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 11: Microwave Oven Wiring and Safety Instructions

Category	Instructions
Wiring	Use grounded outlet with dedicated 15-20A circuit
Power	Ensure voltage matches rating (typically 220-240V)
Installation	Allow 5cm clearance on all sides for ventilation
Safety	Never operate empty, never bypass door interlocks
Maintenance	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 12: Air Conditioner Working Cycle

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

```
flowchart LR
    A[Compressor] -->|High{-}pressure gas| B[Condenser]
    B -->|Liquid| C[Expansion Valve]
    C -->|Low{-}pressure liquid| D[Evaporator]
    D -->|Low{-}pressure gas| A
    E[Room Air] -->|D|
    D -->|F Cool Air|
    F -->|G Outside Air|
    G -->|B|
    B -->|H Hot Air|
```

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 13: 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

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph TD
    A[Electronic Controller] --> B[Microcontroller]
    B --> C[Sensor Inputs]
    B --> D[User Interface]
    B --> E[Actuator Control]
    C --> F[Water Level Sensor]
    C --> G[Temperature Sensor]
    C --> H[Load Balance Sensor]
    C --> I[Door Lock Sensor]
    E --> J[Motor Driver]
    E --> K[Water Valve Control]
    E --> L[Drain Pump Control]
    E --> M[Heater Control]
    N[Fuzzy Logic] --> B
    N --> O[Adaptive Control]
    O --> P[Water Level Adjustment]
    O --> Q[Wash Time Optimization]
    O --> R[Spin Speed Adjustment]
{Highlighting}
{Shaded}
```

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 14: 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 15: 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

```
flowchart LR
    A[Compressor] --> B[Condenser]
    B --> C[High pressure liquid]
    C --> D[Expansion Valve]
    D --> E[Low pressure liquid]
    E --> F[Evaporator]
    F --> G[Low pressure gas]
    G --> A
    H[Thermostat] --> A
```

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:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph LR
    A[Power Supply] --> B[Control Panel/Timer]
    A --> C[High Voltage Transformer]
    B --> D[Door Interlock Switches]
    B --> E[Control Circuit/Microcontroller]
    E --> F[Magnetron Driver]
    C --> F
    F --> G[Magnetron]
    G --> H[Waveguide]
```

```

H {-{-}{}} I[Cooking Cavity]
E {-{-}{}} J[Turntable Motor]
J {-{-}{}} K[Turntable]
E {-{-}{}} L[Cooling Fan]
{Highlighting}
{Shaded}

```

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 16: Multi-Function Printer Specifications

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

Table 17: LCD Projector Specifications

Specification	Typical Range
Brightness	2000-5000 lumens
Resolution	XGA (1024×768) to 4K (3840×2160)
Contrast Ratio	2000:1 to 100,000:1
Lamp Life	4000-8000 hours
Connectivity	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:

Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph TD  
    A[Power Supply] --- B[Control Board/CPU]  
    B --- C[Paper Feed Motor]  
    B --- D[Printhead Motor]  
    B --- E[Printhead Controller]  
    E --- F[Ink Cartridges]  
    F --- G[Printhead Nozzles]  
    B --- H[Input Interface]  
    I[Computer] --- H  
    C --- J[Paper Feed Mechanism]  
    D --- K[Carriage Assembly]  
    K --- F  
    B --- L[Sensors]  
    L --- M[Paper Sensors]  
    L --- N[Ink Level Sensors]  
{Highlighting}  
{Shaded}
```

Working of Inkjet Printer:

1. **Document Processing:** Control board receives data and converts to printer commands
2. **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:

Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph TD  
    A[Control Panel] --- B[Main Control Board]  
    B --- C[Scanning System]  
    C --- D[Light Source]  
    C --- E[Mirrors and Lenses]  
    C --- F[CCD/Image Sensor]  
    B --- G[Imaging System]  
    G --- H[Photosensitive Drum]  
    G --- I[Charging Corona]  
    G --- J[Developing Unit]  
    G --- K[Transfer Corona]
```

```

G {-{-}{}} L[Fusing Unit]
B {-{-}{}} M[Paper Feed System]
M {-{-}{}} N[Paper Trays]
M {-{-}{}} O[Feed Rollers]
M {-{-}{}} P[Registration Rollers]
B {-{-}{}} Q[Power Supply]

{Highlighting}
{Shaded}

```

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:** A3/11×17inches
- **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 18: CCTV System Overview

Aspect	Description
Full Form	Closed-Circuit Television
Purpose	Security monitoring and surveillance
Components	Cameras, DVR/NVR, monitors, cables, power supply
Types	Analog, IP (digital), Wireless, HD-CVI/TVI/SDI
Features	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:

Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Power Supply] --> B[Control Circuit]  
    B --> C[Lamp/Light Source]  
    C --> D[Cooling System]  
    C --> E[Reflector]  
    E --> F[Condenser Lens]  
    F --> G[Dichroic Mirrors]  
    G --> H[Red LCD Panel]  
    G --> I[Green LCD Panel]  
    G --> J[Blue LCD Panel]  
    H --> K[Combining Prism]  
    I --> K  
    J --> K  
    K --> L[Projection Lens]  
    L --> M[Screen]  
    B --> N[Input Interfaces]  
    B --> O[Keystone Correction]  
    B --> P[Focus Control]  
{Highlighting}  
{Shaded}
```

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:

Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph TD  
    A[Control Board] --> B[Laser Diode]  
    A --> C[Polygon Mirror Motor]  
    B --> D[Polygon Mirror]  
    D --> E[Focusing Lenses]  
    E --> F[Photosensitive Drum]  
    A --> G[Primary Corona]  
    G --> F  
    A --> H[Developer Unit]  
    H --> F  
    A --> I[Transfer Corona]
```

```

I {-{-}{}} F}
A {-{-}{}} J[Fusing Unit]
A {-{-}{}} K[Paper Feed Mechanism]
K {-{-}{}} L[Paper Path]
L {-{-}{}} J}
A {-{-}{}} M[Power Supply]
A {-{-}{}} N[Interface]
{Highlighting}
{Shaded}

```

Laser Printing Process:

Table 19: 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 20: 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:

Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Microphone] --> B[Pre{-}amplifier]  
    B --> C[Mixer]  
    D[Audio Source] --> C  
    E[Equalizer] --> C  
    C --> F[Power Amplifier]  
    F --> G[Speaker System]  
    H[Control System] --> C  
    H --> F  
{Highlighting}  
{Shaded}
```

Table 21: 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 22: Crystal Microphone Characteristics

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

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph LR
    A[Sound Waves] --> B[Diaphragm]
    B --> C[Mechanical Stress on Crystal]
    C --> D[Piezoelectric Effect]
    D --> E[Voltage Generation]
    E --> F[Electrical Output]
{Highlighting}
{Shaded}
```

Applications:

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

Advantages and Limitations:

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:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph TD
    A[Audio/Video Source] --> B[AV Receiver/Amplifier]
    B --> C[Front Left Speaker]
    B --> D[Center Speaker]
    B --> E[Front Right Speaker]
    B --> F[Surround Left Speaker]
    B --> G[Surround Right Speaker]
    B --> H[Subwoofer]
    I[Remote Control] --> B
    J[TV/Display] --> B
    B --> J
    K[Streaming Module] --> B
{Highlighting}
{Shaded}
```

Mnemonic

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

Question 5(b OR) [4 marks]

Explain optical sound recording.

Solution

Table 23: Optical Sound Recording Process

Step	Process	Component
1	Sound Capture	Microphone converts sound to electrical signals
2	Modulation	Signal modulates light source intensity or area
3	Exposure	Modulated light exposes photographic film
4	Development	Film processed to create visible sound track
5	Playback	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

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph LR
    A[Sound Input] --> B[Microphone]
    B --> C[Amplifier]
    C --> D[Light Modulator]
    E[Light Source] --> D
    D --> F[Optical System]
    F --> G[Moving Film]
    H[Developed Film] --> I[Playback Light Source]
    I --> J[Photocell/Detector]
    J --> K[Amplifier]
    K --> L[Speaker]
{Highlighting}
{Shaded}
```

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 24: Types of Loudspeakers

Type	Working Principle	Frequency Range	Applications
Dynamic/Moving Coil	Magnetic 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 force on conductor sheet	30Hz-20kHz	Audiophile headphones, speakers
Magnetic			

Working of Dynamic/Moving Coil Loudspeaker:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph LR
    A[Audio Signal] --> B[Voice Coil]
    B --> C[Electromagnetic Field]
    D[Permanent Magnet] --> C
    C --> E[Movement of Voice Coil]
    E --> F[Cone/Diaphragm Movement]
    F --> G[Air Pressure Variations]
    G --> H[Sound Waves]

{Highlighting}
{Shaded}
```

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”