Subject Name Solutions

4341107 – Winter 2024

Semester 1 Study Material

Detailed Solutions and Explanations

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:

Type	Key Feature
Dynamic/Moving Coil	Uses electromagnetic coil
Electrostatic	Uses charged diaphragm
Ribbon	Uses thin metal ribbon
Piezoelectric	Uses crystals that vibrate
Horn	Uses acoustic horn for amplification
Planar Magnetic	Uses magnetic strips on diaphragm

Dynamic/Moving Coil Loudspeaker:

```
flowchart LR
    A[Audio Signal] {-{-} B[Voice Coil]}
    B {-{-} C[Electromagnetic Field]}
    C {-{-} D[Coil Movement]}
    D {-{-} E[Cone/Diaphragm Vibration]}
    E {-{-} F[Sound Waves]}
```

- **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:

Type	Operating Principle
Dynamic	Moving coil in magnetic field
Condenser	Variable capacitance
Carbon	Variable resistance
Ribbon	Ribbon movement in magnetic field
Crystal/Piezoelectric	Crystal deformation
Electret	Permanently charged material
MEMS	Micro-Electro-Mechanical Systems

Microphone Characteristics:

- **Sensitivity**: Output level for given sound pressure
- **Frequency Response**: Range of frequencies captured
- **Directional Pattern**: Pickup pattern (omnidirectional, cardioid, etc.)
- **Impedance**: Electrical resistance to AC signals
- **Signal-to-Noise Ratio**: Desired signal vs. background noise

Wireless Microphone System:

```
flowchart LR
    A[Sound Input] {-{-} B[Microphone Element]}
    B {-{-} C[Preamplifier]}
    C {-{-} D[Compressor]}
    D {-{-} E[RF Transmitter]}
    E {-{-} "Radio Waves" {-}{-} F[RF Receiver]}
    F {-{-} G[Demodulator]}
    G {-{-} H[Expander]}
    H {-{-} I[Output Signal]}
```

- **Microphone Element**: Converts sound to electrical signals
- **Transmitter**: Modulates audio onto radio frequency carrier
- **Receiver**: Captures RF signal and demodulates to recover audio
- **Operating Frequency**: Uses VHF (30-300 MHz) or UHF (300-3000 MHz) bands
- **Battery Operation**: Requires power source for transmitter

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:

Characteristic	Description
Frequency Response	Range of frequencies reproduced (20Hz-20kHz ideal)
Sensitivity	Sound pressure level (dB) with 1W input at 1m distance
Impedance	Electrical resistance (typically 4, 8, or 16 ohms)
Power Handling	Maximum power without damage (watts)

Directivity	Sound dispersion pattern
Distortion	Unwanted alteration of the original signal

Permanent Magnet Loudspeaker:

```
flowchart LR
    A[Audio Signal] {-{-} B[Voice Coil]}
    B {{-}{-} C[Magnetic Field]}
    C {-{-}{-} D[Permanent Magnet]}
    B {-{-} E[Diaphragm Movement]}
    E {-{-} F[Sound Waves]}
```

Working Principle:

- Voice coil receives electrical audio signals
- Magnetic field interactions cause coil movement
- Attached diaphragm vibrates to produce sound
- Permanent magnet provides constant magnetic field

Advantages:

- **Cost-effective**: No external power for magnetic field
- **Reliable**: Simple design with fewer failure points
- **Compact**: No field coil or power supply needed
- **Efficient**: Good power-to-sound conversion

Disadvantages:

- **Limited Power**: Magnetic field strength is fixed
- **Magnet Deterioration**: Can weaken over time
- **Weight**: Strong magnets can make unit heavy
- **Heat Sensitivity**: Performance affected by temperature

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	The ratio of width to height of a television or display screen (e.g., 16:9, 4:3)
Chrominance	The color information in a video signal, independent of the luminance or brightness
Additive Mixing	The process of combining different colored lights to create new colors, where mixing all primary colors produces white

Mnemonic

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

Question 2(b) [4 marks]

Explain interlace scanning

Solution

Interlace Scanning:

```
flowchart LR
```

```
    A[Complete Frame] {-{-} B[Odd Lines]}
    A {-{-} C[Even Lines]}
    B {-{-} D[First Field]}
    C {-{-} E[Second Field]}
    D {-{-} F[Display]}
    E {-{-} F}
```

Process:

- Frame divided into two fields: odd-numbered lines and even-numbered lines
- First field displays all odd-numbered lines (1,3,5...)
- Second field displays all even-numbered lines (2,4,6...)
- Fields displayed alternately, creating illusion of full frame
- Standard rate: 50/60 fields per second (25/30 frames per second)

Key Benefit: Reduces bandwidth while maintaining perceived vertical resolution

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

LED TV Working Principle:

```
flowchart LR
    A[Input Signal] {-{-} B[Signal Processing]}
    B {-{-} C[LCD Panel]}
    D[LED Backlight] {-{-} C}
    C {-{-} E[Polarizing Filters]}
    E {-{-} F[Color Filters]}
    F {-{-} G[Screen Display]}
```

Key Components:

- **LED Backlight**: Light source (edge-lit or full-array)
- **LCD Panel**: Liquid crystal layer controls light passage
- **TFT Matrix**: Thin-film transistors control each pixel
- **Color Filters**: Create RGB colors from white backlight
- **Polarizing Filters**: Control light direction and intensity

Advantages of LED TV:

- **Energy Efficient**: Consumes less power
- **Thinner Design**: Allows for slim profile
- **Better Contrast**: Especially with local dimming
- **Longer Lifespan**: LEDs last 50,000-100,000 hours
- **Eco-Friendly**: No mercury content

Comparison with LCD TV:

Feature	LED TV	LCD TV
Backlight	LED lights	CCFL (Cold Cathode Fluorescent Lamps)
Thickness	Thinner (25-40mm)	Thicker (100-150mm)
Power Consumption	Lower	Higher
Contrast Ratio	Better (3000:1-8000:1)	Lower (1000:1-2000:1)
Color Reproduction	More vibrant	Less vibrant
Lifespan	50,000-100,000 hours	30,000-60,000 hours
Cost	Higher	Lower

Mnemonic

"LEDGE: Light Emitting Diodes Give Excellence"

Question 2(a) [3 marks]

State any six standards of Color television system.

Solution

Standard	Region/Features
PAL (Phase Alternating Line)	Europe, Australia, 625 lines, 25 fps
NTSC (National Television System Committee)	North America, Japan, 525 lines, 30 fps
SECAM (Sequential Color with Memory)	France, Russia, 625 lines, 25 fps
PAL-M	Brazil, 525 lines, 30 fps
PAL-N	Argentina, Paraguay, Uruguay
ATSC (Advanced Television Systems Committee)	Digital standard, North America
DVB-T (Digital Video Broadcasting-Terrestrial)	Digital standard, Europe
ISDB (Integrated Services Digital Broadcasting)	Digital standard, Japan, Brazil

Mnemonic

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

Question 2(b) [4 marks]

Explain working of LCD Television.

Solution

LCD Television Working:

```
flowchart LR
    A[Input Signal] {-{-} B[Signal Processor]}
    B {-{-} C[LCD Driver Circuits]}
    D[Backlight] {-{-} E[Diffuser]}
    E {-{-} F[Polarizing Filter 1]}
    F {-{-} G[LCD Panel]}
    C {-{-} G}
    G {-{-} H[Polarizing Filter 2]}
    H {-{-} I[Color Filters]}
    I {-{-} J[Screen Display]}
```

Operating Principle:

- **Backlight**: Provides white light source
- **Polarizing Filters**: Two filters at 90°*toeachother*
- **Liquid Crystals**: Twist/untwist to control light passage
- **TFT Array**: Controls voltage to each pixel
- **Color Filters**: Create RGB colors from white light

Mnemonic

"BPLTC: Backlight Passes through Liquid crystals That Color"

Question 2(c) [7 marks]

Draw and Explain block diagram of PAL-D decoder.

Solution

PAL-D Decoder:

```
flowchart LR
    A[Composite Video Input] {-{-} B[Y/C Separator]}
    B {-{-} C[Luminance Y Processing]}
    B {-{-} D[Chrominance Processing]}
    D {-{-} E[Delay Line]}
    D {-{-} F[PAL Switch]}
    E {-{-} F}
    F {-{-} G[U/V Demodulator]}
    G {-{-} H[U Signal]}
    G {-{-} I[V Signal]}
    C {-{-} J[RGB Matrix]}
    H {-{-} J}
    I {-{-} J}
    J {-{-} K[RGB Output]}
```

PAL-D Decoder Components:

- **Y/C Separator**: Separates luminance (Y) from chrominance (C)
- **Luminance Processing**: Enhances brightness and contrast
- **Chrominance Processing**: Extracts color subcarrier
- **Delay Line**: Delays signal by one line (64µs)
- **PAL Switch**: Reverses phase of V signal on alternate lines
- **U/V Demodulator**: Extracts U (B-Y) and V (R-Y) color difference signals
- **RGB Matrix**: Combines Y, U, V to produce RGB signals

Key Feature: Phase alternation corrects phase errors by averaging consecutive lines

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

Rooftop Solar Power Plant Types:

Type	Description
Grid-Connected	Connected to utility grid, no batteries
Off-Grid	Standalone system with battery storage
Hybrid	Can operate in both grid-connected and off-grid modes

Grid-Connected System:

```
flowchart LR
    A[Solar Panels] {-{-} B[DC{-}AC Inverter]}
    B {-{-} C[Bi{-}directional Meter]}
    C {-{-} D[Utility Grid]}
    C {-{-} E[Home Load]}
```

- **Solar Panels**: Convert sunlight to DC electricity
- **Inverter**: Converts DC to grid-compatible AC
- **Meter**: Measures power exported/imported
- **Grid Connection**: Excess power fed to grid

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/Description
Capacity	150-750 liters
Energy Rating	Star rating (1-5 stars)
Power Consumption	100-400 kWh per year
Compressor Type	Reciprocating or inverter
Defrost System	Manual, frost-free, or direct cool
Refrigerant Type	R-600a, R-134a
Temperature Range	2-8$^{(}refrigerator), -18to-24^{(}freezer)$

Split Air Conditioner Specifications:

Specification	Typical Range/Description
Cooling Capacity	1-2 tons (12,000-24,000 BTU/hr)
Energy Efficiency Ratio (EER)	2.8-3.5 W/W
ISEER Rating	Star rating (1-5 stars)
Power Consumption	800-2500 watts
Refrigerant Type	R-32, R-410A
Noise Level	30-55 dB
Operating Temperature Range	18-32$^{(}indoor), -5to55^{(}outdoor)$

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

Microwave Oven Working Principle: Food contains water molecules, which are polar. Microwaves cause these molecules to rotate rapidly (2.45 GHz), creating friction and generating heat throughout the food.
Functional Block Diagram:

```
flowchart LR
    A[Control Panel] {-{-} B[Control Circuit]}
    B {-{-} C[Timer]}
    B {-{-} D[Power Control]}
    D {-{-} E[High Voltage Transformer]}
    E {-{-} F[High Voltage Capacitor]}
    E {-{-} G[High Voltage Diode]}
    F {-{-} H[Magnetron]}
    G {-{-} H}
    H {-{-} I[Waveguide]}
    I {-{-} J[Cooking Cavity]}
    K[Turntable Motor] {-{-} L[Turntable]}
    B {-{-} K}
```

```
    L {-{-} J}
```

Key Components:

- **Magnetron**: Generates microwave radiation (2.45 GHz)
- **Waveguide**: Directs microwaves to cooking cavity
- **Turntable**: Ensures even cooking
- **Control Circuit**: Manages timing and power
- **High Voltage Circuit**: Powers the magnetron

Safety Precautions:

- **Door Interlocks**: Multiple switches prevent operation when door is open
- **Monitoring Circuit**: Shuts down if interlocks fail
- **Cavity Mesh Screen**: Blocks microwaves from escaping
- **Never Operate Empty**: Can damage magnetron
- **No Metal Objects**: Can cause arcing and damage
- **Regular Cleaning**: Prevents food buildup and arcing
- **Avoid Damaged Seals**: May allow microwave leakage

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

Rooftop Solar Power Plant Hardware:

Component	Function
Solar Panels	Convert sunlight to DC electricity
Mounting Structure	Supports panels at optimal angle
Inverter	Converts DC to AC power
Batteries (optional)	Store energy for later use
Charge Controller	Regulates battery charging (in off-grid systems)
Junction Boxes	Provide connection points and protection
Meters	Measure power generation/consumption
Cables & Connectors	Transmit power between components

Solar Panels:

```
flowchart LR
    A[Sunlight] {-{-} B[Tempered Glass]}
    B {-{-} C[Anti{-}Reflective Coating]}
    C {-{-} D[EVA Encapsulant]}
    D {-{-} E[Silicon Solar Cells]}
    E {-{-} F[Backsheet]}
    G[Aluminum Frame] {-{-} H[Complete Panel]}
    F {-{-} H}
```

- **Monocrystalline**: Higher efficiency (15-22%), darker color, longer lifespan
- **Polycrystalline**: Lower cost, blue appearance, 13-17% efficiency
- **Thin-Film**: Flexible, lightweight, lower efficiency (10-12%)
- **Typical Output**: 250-400W per panel
- **Lifespan**: 25-30 years with warranty

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 Specifications:

Specification	Typical Range/Description
Power Output	700-1200 watts
Capacity	15-42 liters
Frequency	2.45 GHz
Operating Modes	Microwave, grill, convection, combo
Control Type	Mechanical, digital, touch panel
Power Consumption	1000-1500 watts
Timer Range	0-60 minutes

Washing Machine Specifications:

Specification	Typical Range/Description
Capacity	5-12 kg
Washing Technology	Agitator, impeller, drum
Spin Speed	700-1600 RPM
Water Consumption	30-80 liters per cycle
Energy Rating	Star rating (1-5 stars)
Program Options	8-16 programs
Motor Type	Universal, inverter, direct drive

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

Washing Machine Classification:

Type	Subtype	Key Features
Top Load	Agitator	Central post that rotates
	Impeller	Rotating disk at bottom
Front Load	Horizontal Axis	Tumbling action, water efficient
By Automation	Fully Automatic	Complete cycle automation
	Semi-Automatic	Manual intervention required
By Function	Washer Only	Washing function only
	Washer-Dryer	Combined washing and drying

Top Load Washing Machine Functional Block Diagram:

```
flowchart LR
    A[Control Panel] {-{-} B[Main Control Board]}
    B {-{-} C[Water Inlet Valve]}
    B {-{-} D[Water Level Sensor]}
    B {-{-} E[Motor Controller]}
    E {-{-} F[Main Motor]}
    F {-{-} G[Transmission]}
    G {-{-} H[Agitator/Impeller]}
    G {-{-} I[Spin Basket]}
    B {-{-} J[Drain Pump]}
    B {-{-} K[Timer]}
```

Working Strategy/Steps:

1. **Fill Phase**:
   - Water inlet valve opens
   - Tub fills to preset level
   - Detergent mixed with water
2. **Wash Phase**:
   - Motor drives agitator/impeller
   - Creates water currents
   - Clothing moves through soapy water
   - Dirt loosened by mechanical action
3. **Drain Phase**:
   - Drain pump activates
   - Soapy water removed
4. **Rinse Phase**:
   - Fresh water enters
   - Agitator/impeller removes soap residue
   - May repeat multiple times
5. **Spin Phase**:
   - Basket rotates at high speed
   - Centrifugal force removes water
   - Clothes partially dried

Mnemonic

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

Question 4(a) [3 marks]

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

Solution

Laser Printer Working Principle: Based on electrophotography where a laser beam creates an electrostatic image on a photosensitive drum, which attracts toner particles that are then transferred to paper and fused with heat.

Technical Specifications:

Specification	Typical Range/Values
Print Resolution	600-1200 dpi
Print Speed	20-50 ppm (pages per minute)
Duty Cycle	10,000-100,000 pages/month
Memory	64-512 MB
Connectivity	USB, Ethernet, Wi-Fi
Paper Capacity	250-500 sheets
Power Consumption	300-800W (active), <10W (standby)