

2017

**MADE EASY
WORKBOOK**

**Communication Systems + Electrical
Materials + Computer Fundamentals**

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Communication Systems Description Sheet

Chapter-1 : Amplitude Modulation

- Concept of modulation
 - Basic functional block diagram of communication systems
 - Basic properties of F.T.
 - Introduction to modulation
- Amplitude modulation
 - Expression and spectrum of AM
 - Generation and Demodulation of AM
 - Power and current relations in AM
- DSB-SC
- SSB-SC
- Basics of VSB
- Comparison of AM/DSB/SSB/VSB
- FDM (Frequency division multiplying)
- QCM (Quadrature carrier multiplexing)

Chapter-2 : Angle Modulation

- Basic concept of frequency and phase modulation
- Spectrum of FM
- General expression of FM
 - Single tone FM
- Power and BW of FM
 - Carson's rule
- Generation and Demodulation of FM
- General expression of PM
- Relation between FM and PM
- Frequency and Phase deviation of PM and FM

Chapter-3 : Receivers

- Classification of receivers
 - TRF
 - SHD

- AM RX (TRF type)
 - Drawbacks of TRF receiver
- AM RX (SHD type)
 - Block diagram
 - Advantages of SHD RX over TRF RX
 - Drawbacks of SHD RX (Image frequency)
 - Suppression of image frequency
 - Mixer
 - ⇒ Up conversion
 - ⇒ Down conversion
- Pre-emphasis and De-emphasis (Basics)

Chapter-4 : Sampling Theorem and PCM

- Sampling theory
- PCM
 - Block diagram
 - Quantization
 - Encoding
- Bandwidth and bit rate of PCM
- Signal to quantization noise power ratio
- Companding
- ISI and its mitigation
- TDM (Time division multiplexing)
- DPCM (Basics)
- DM and ADM

Chapter-5 : Miscellaneous

Digital Carrier Modulation Schemes:

- ASK
- PSK
- FSK
 - Generation and demodulation
 - Bandwidth
 - Constellation diagram

Information Theory:

- Basics probability theory
- Entropy
- Channel capacity theory
- Introduction to random variables
 - Cumulative distribution functions
 - Probability density function
 - Mean, Mean square value, variance, standard deviation of random variable

Note: Information theory and random variable are not the part of the syllabus but due to the presence of questions in examinations only basics of these topics are to be discussed.

Noise:

- Classification of noise
- White noise
- Properties
- ACF and PSD
- SNR of AM, DSB, SSB, FM

Power line carrier

Communication systems



1

Amplitude Modulation

Q.1 A 10 kW carrier is sinusoidally modulated by two carriers corresponding to a modulation index of 30% and 40% respectively. The total radiated power is

- (a) 11.25 kW (b) 12.5 kW
(c) 15 kW (d) 17 kW

Q.2 12 signals each band-limited to 5 kHz are to be transmitted over a single channel by frequency division multiplexing. If AM-SSB modulation guard band of 1 kHz is used, then the bandwidth of the multiplexed signal will be

- (a) 51 kHz (b) 61 kHz
(c) 71 kHz (d) 81 kHz

Q.3 In an amplitude modulated system, if the total power is 600 W and the power in carrier is 400 W, then the modulation index is

- (a) 0.5 (b) 0.75
(c) 0.9 (d) 1

Q.4 For an AM wave, the maximum voltage was found to be 10 V and the minimum voltage was found to be 5 V. The modulation index of the wave would be

- (a) 0.33 (b) 0.52
(c) 0.40 (d) 0.1

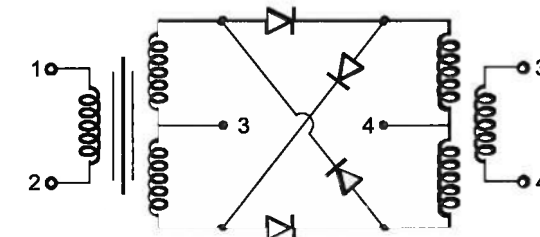
Q.5 In a broadcast transmitter, the RF output is represented as

$$e(t) = 50 [1 + 0.89 \cos 5000t + 0.30 \sin 9000t] \cos(6 \times 10^6 t) \text{ volt}$$

What are the sidebands of the signals in radians?

- (a) 5×10^3 and 9×10^3
(b) 5.991×10^6 , 5.995×10^6 , 6.005×10^6 and 6.009×10^6
(c) 4×10^3 , 1.4×10^4
(d) 1×10^6 , 11×10^7 , 3×10^6 and 1.5×10^7

Q.6 In the circuit shown above, the transformers are centre tapped and the diodes are connected as shown in a bridge. Between the terminals 1 and 2 an a.c. voltage source of frequency 400 Hz is connected. Another a.c. voltage of 1.0 MHz is connected between 3 and 4. The output between 5 and 6 contains components at



- (a) 400 Hz, 1.0 MHz, 1000.4 kHz, 999.6 kHz
(b) 400 Hz, 1000.0 kHz, 999.6 kHz
(c) 1 MHz, 1000.4 kHz, 999.6 kHz
(d) 1000.4 kHz, 999.6 kHz

Q.7 Which of the following demodulator can be used for demodulating the signal?

$$x(t) = 5[1 + 2 \cos 200\pi t] \cos 2000\pi t$$

- (a) Envelope demodulator
(b) Square law demodulator
(c) Synchronous detector
(d) None of the above

Q.8 A modulated signal is given by,
 $s(t) = m_1(t) \cos(2\pi f_c t) + m_2(t) \sin(2\pi f_c t)$
 where the baseband signal $m_1(t)$ and $m_2(t)$ have bandwidths of 10 kHz and 15 kHz, respectively. The bandwidth of the modulated signal, in kHz, is

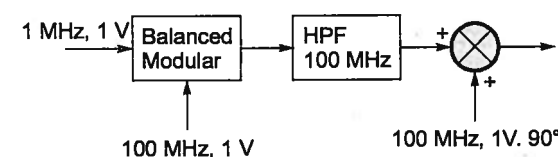
- (a) 10 (b) 15
(c) 25 (d) 30

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- Q.9 The amplitude modulated waveform $s(t) = A_c [1 + K_a m(t)] \cos \omega_c t$ is fed to an ideal envelope detector. The maximum magnitude of $K_a m(t)$ is greater than 1, which of the following could be the detector output?
- (a) $A_c m(t)$ (b) $A_c^2 [1 + K_a m(t)]^2$
(c) $A_c [1 + K_a m(t)]$ (d) $A_c [1 + K_a m(t)]^2$
- Q.11 The Hilbert transform of $\cos \omega_1 t + \sin \omega_2 t$ is
- (a) $\sin \omega_1 t - \cos \omega_2 t$ (b) $\sin \omega_1 t + \cos \omega_2 t$
(c) $\cos \omega_1 t - \sin \omega_2 t$ (d) $\sin \omega_1 t + \sin \omega_2 t$
- Q.12 A 1 MHz sinusoidal carrier is amplitude modulated by a symmetrical square wave of period 100 μsec . Which of the following frequencies will NOT be present in the modulated signal?
- (a) 990 kHz (b) 1010 kHz
(c) 1020 kHz (d) 1030 kHz
- Q.13 A DSB-SC signal is to be generated with a carrier frequency $f_c = 1 \text{ MHz}$ using a non-linear device with the input-output characteristic $V_0 = a_0 v_i + a_1 v_i^3$ where a_0 and a_1 are constants. The output of the non-linear device can be filtered by an appropriate band-pass filter. Let $v_i = A_c^i \cos(2\pi f_c^i t) + m(t)$ where $m(t)$ is the message signal. Then the value of f_c^i (in MHz) is
- (a) 1.0 (b) 0.333
(c) 0.5 (d) 3.0
- Q.14 An AM signal is detected using an envelope detector. The carrier frequency and modulating signal frequency are 1 MHz and 2 kHz respectively. An appropriate value for the time constant of the envelope detector is
- (a) 500 μsec (b) 20 μsec
(c) 0.2 μsec (d) 1 μsec
- Q.15 A 100 MHz carrier of 1 V amplitude and a 1 MHz modulating signal of 1 V amplitude are fed to a balanced modulator. The output of the modulator is passed through an ideal high-pass filter with

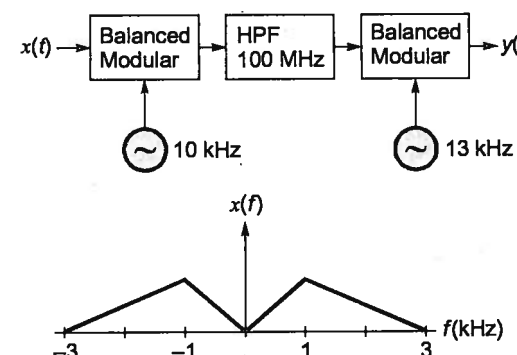
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cut-off frequency of 100 MHz. The output of the filter is added with 100 MHz signal of 1 V amplitude and 90° phase shift as shown in the figure. The envelope of the resultant signal is



- (a) constant
(b) $\sqrt{1 + \sin(2\pi \times 10^6 t)}$
(c) $\sqrt{5/4 - \sin(2\pi \times 10^6 t)}$
(d) $\sqrt{5/4 + \cos(2\pi \times 10^6 t)}$

Q.16 Consider a system shown in the figure. Let $X(f)$ and $Y(f)$ denote the Fourier transforms of $x(t)$ and $y(t)$ respectively. The ideal HPF has the cutoff frequency 10 kHz.



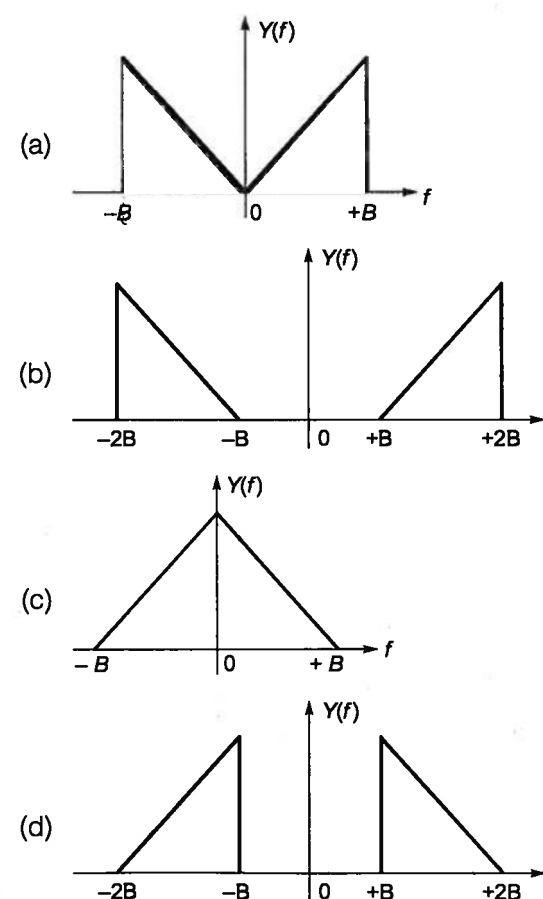
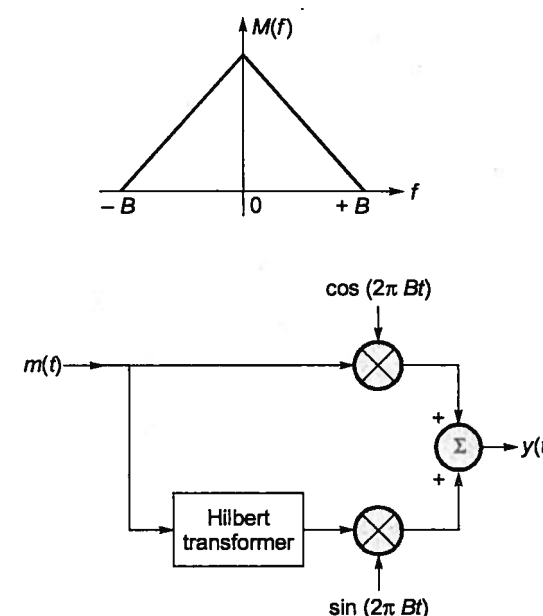
The positive frequencies where $Y(f)$ has spectral peaks are

- (a) 1 kHz and 24 kHz
(b) 2 kHz and 24 kHz
(c) 1 kHz and 14 kHz
(d) 2 kHz and 14 kHz

Q.17 Let $g(t) = p(t) * p(t)$, where $*$ denotes convolution and $p(t) = u(t) - u(t - 1)$ with $u(t)$ being the unit step function. An Amplitude Modulated signal is given as $x_{AM}(t) = 100(p(t) + 0.5g(t)) \cos \omega_c t$ in the interval $0 \leq t \leq 1$. One set of possible values of the modulating signal and modulation index would be

(a) t , 0.5 (b) t , 1.0
(c) t , 2.0 (d) t^2 , 0.5

Q.18 In the following scheme, if the spectrum $M(f)$ of $m(t)$ is as shown, then the spectrum $Y(f)$ of $y(t)$ will be



- Q.19 Consider the amplitude modulated signal $A_c \cos \omega_c t + 2 \cos \omega_m t \cos \omega_c t$. For demodulating the signal using envelope detector, the minimum value of A_c should be
- (a) 2 (b) 1
(c) 0.5 (d) 0
- Q.20 For a message signal $m(t) = \cos 2\pi f_m t$ and carrier of frequency f_c , which of the following represents a single side-band (SSB) signal?
- (a) $\cos 2\pi f_c t \cos 2\pi f_m t$
(b) $\cos 2\pi f_c t$
(c) $\cos 2\pi (f_c + f_m) t$
(d) $[1 + \cos 2\pi f_m t] \cos 2\pi f_c t$
- Q.21 For an AM signal, the bandwidth is 10 kHz and the highest frequency component present is 705 kHz. The carrier frequency used for this AM signal is
- (a) 695 kHz (b) 700 kHz
(c) 705 kHz (d) 710 kHz
- Q.22 In amplitude modulation, the modulation envelope has a peak value which is double the unmodulated carrier value. What is the value of the modulation index?
- (a) 25% (b) 50%
(c) 75% (d) 100%
- Q.23 An AM voltage signal $s(t)$, with a carrier frequency of 1.15 GHz has a complex envelope $g(t) = A_c [1 + m(t)]$, $A_c = 500 \text{ V}$, and the modulation is a 1 kHz sinusoidal test tone described by $m(t) = 0.8 \sin(2\pi \times 10^3 t)$, appears across a 50 Ω resistive load. What is the actual power dissipated in the load?
- (a) 165 kW (b) 82.5 kW
(c) 3.3 kW (d) 6.6 kW
- Q.24 A given AM broadcast station transmits an average carrier power output of 40 kW and uses a modulation index of 0.707 for sine wave modulation. What is the maximum (peak) amplitude of the output if the antenna is represented by a 50 Ω resistive load?
- (a) 50 kV (b) 50 V
(c) 3.414 kV (d) 28.28 kV

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Q.25 A carrier voltage has a peak amplitude of 10 V at a frequency of 1×10^6 Hz. A sinusoidal signal of 1 kHz varies the amplitude of RF wave between 7.5 and 12.5 volts. The peak amplitude of the modulating signal is

- (a) 10 V (b) 2.5 V
(c) 7.5 V (d) 12.5 V

Q.26 A message signal $m(t) = \cos 2000\pi t + 4 \cos 4000\pi t$ modulates the carrier $c(t) = \cos 2\pi f_c t$ where $f_c = 1$ MHz to produce an AM signal. For demodulating the generated AM signal using an envelope detector, the time constant RC of the detector circuit should satisfy

- (a) $0.5 \text{ ms} < RC < 1 \text{ ms}$
(b) $1 \mu\text{s} \ll RC < 0.5 \text{ ms}$
(c) $RC \ll 1 \mu\text{s}$
(d) $RC \gg 0.5 \text{ ms}$

Q.27 Amplitude modulation is used for broadcasting because

- (a) it is more noise immune than other modulation systems.
(b) compared with other system it require less transmitting power.
(c) its use avoids receiver complexity
(d) no other modulation system can provide the necessary BW for high fidelity.

Q.28 A carrier signal $c(t) = 10\cos 2\pi \times 10^6 t$ is amplitude modulated by a message signal $m(t) = \cos 2\pi \times 10^4 t$. If the modulation index of generated AM is 0.5. The ratio of lower sideband power to the carrier power is _____.

- (a) $\frac{1}{2}$ (b) $\frac{1}{4}$
(c) $\frac{1}{8}$ (d) $\frac{1}{16}$

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2

Angle Modulation

Q.1 In phase modulation, the frequency deviation is

- (a) independent of the modulating signal frequency
(b) inversely proportional to the modulating signal frequency
(c) directly proportional to the modulating signal frequency
(d) inversely proportional to the square root of the modulating frequency

Q.2 An angle-modulated signal is expressed by

$$f_a(t) = \cos(2 \times 10^8 \pi t + 75 \sin 2 \times 10^3 \pi t)$$

The peak frequency deviation of the carrier is then

- (a) 1 kHz (b) 7.5 kHz
(c) 75 kHz (d) 100 MHz

Q.3 An angle-modulated signal is given by

$$s(t) = \cos 2\pi(2 \times 10^6 t + 30 \sin 150t + 40 \cos 150t)$$

The maximum frequency and phase deviations of $s(t)$ are

- (a) 10.5 kHz, 140π rad
(b) 6 kHz, 80π rad
(c) 10.5 kHz, 100π rad
(d) 7.5 kHz, 100π rad

Q.4 Let $m(t) = \cos[4\pi \times 10^3 t]$ be the message

signal and $c(t) = 5\cos[2\pi \times 10^6 t]$ be the

carrier. $c(t)$ and $m(t)$ are used to generate an FM signal. If the peak frequency deviation of the generated FM signal is three times the transmission bandwidth of the AM signal, then the coefficient of the term $\cos[2\pi(1008 \times 10^3)t]$ in the FM signal (in terms of the Bessel coefficients) is

- (a) $5J_4(3)$ (b) $\frac{5}{2}J_8(3)$
(c) $\frac{5}{2}J_8(4)$ (d) $5J_4(6)$

Q.5 A composite signal $x_c(t)$ is expressed as:
 $x_c(t) = A_c \cos(\omega_c t) - A_m \cos(\omega_c - \omega_m)t + A_m \cos(\omega_c + \omega_m)t$

Which of the following methods can be employed to retrieve the sinusoidal component at ω_m from $x_c(t)$?

- (a) An envelope detector, square law detector
(b) Only a discriminator
(c) Only a square law detector
(d) Only an envelope detector

Q.6 A device with input $x(t)$ and output $y(t)$ is characterized by: $y(t) = x^2(t)$.

An FM signal with frequency deviation of 90 kHz and modulating signal bandwidth of 5 kHz is applied to this device. The bandwidth of the output signal is

- (a) 370 kHz (b) 190 kHz
(c) 380 kHz (d) 95 kHz

Q.7 A carrier is phase modulated (PM) with frequency deviation of 10 kHz by a single tone frequency of 1 kHz. If the single tone frequency is increased to 2 kHz, assuming that phase deviation remains unchanged, the bandwidth of the PM signal is

- (a) 21 kHz (b) 22 kHz
(c) 42 kHz (d) 44 kHz

Q.8 An FM wave uses a 2.5 V, 500 Hz modulating frequency and has a modulation index of 50.

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The deviation is

- (a) 500 Hz (b) 100 Hz
(c) 1250 Hz (d) 25000 Hz

- Q.9 In an FM system the deviation is 4 kHz when the modulating voltage is 3 V and modulating frequency is 400 Hz. If the modulating frequency increases to 1000 Hz and its amplitude to 5 V then the modulation index will
(a) remain the same (b) increase
(c) decrease (d) be indeterminate

- Q.10 A frequency-modulated voltage wave is given as $V = 10 \sin(2\pi \times 10^8 t + 5 \sin 400\pi t)$. The carrier frequency and maximum deviation of the signal are respectively
(a) 10 MHz and 10 kHz
(b) 100 MHz and 1 kHz
(c) 10 MHz and 1 kHz
(d) 100 MHz and 10 kHz

- Q.11 Two carriers 40 MHz and 80 MHz respectively are frequency modulated by a signal of frequency 4 kHz, such that the bandwidths of the FM signal in the two cases are the same. The peak deviation in the two cases are in the ratio of
(a) 1 : 4 (b) 1 : 2
(c) 1 : 1 (d) 2 : 1

- Q.12 An FM signal with modulation index m_f is passed through a frequency tripler. The modulation index of the output signal will be
(a) m_f (b) $3 m_f$
(c) $9 m_f$ (d) $27 m_f$

- Q.13 An angle-modulated signal with carrier frequency

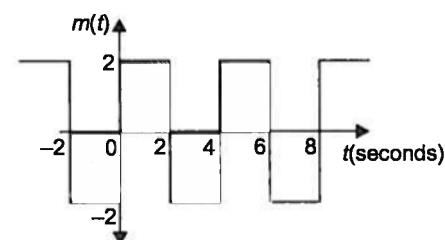
$$\omega_c = 2\pi \times 10^5 \text{ is described by the equation}$$

$$\phi(t) = 10 \cos(\omega_c t + 5 \sin 3000t + 10 \sin 2000\pi t)$$

the deviation ratio is approximately equal to

- (a) 21 (b) 6
(c) 12 (d) 15

- Q.14 The signal $m(t)$ as shown is applied both to a phase modulator (with k_p as the phase constant) and a frequency modulator with (k_f as the frequency constant) having the same carrier frequency



The ratio k_p/k_f (in rad/Hz) for the same maximum phase deviation is

- (a) 8π (b) 4π
(c) 2π (d) π

- Q.15 The power dissipated by a frequency modulated wave in 10Ω resistance when amplitude of carrier wave is 12 V and amplitude of message signal is 6 V will be _____ watts.
(a) 14.4 (b) 7.2
(c) 3.6 (d) 1.8

■■■■

3

Radio Receivers

- Q.1 In a superheterodyne receiver, the IF is 455 kHz. If it is tuned to 1200 kHz, the image frequency will be
(a) 1655 kHz (b) 745 kHz
(c) 2110 kHz (d) 910 kHz

- Q.2 A superheterodyne receiver is to operate in the frequency range 550 kHz - 1650 kHz, with the intermediate frequency of 450 kHz.

Let $R = \frac{C_{\max}}{C_{\min}}$ denote the required capacitance

ratio of the local oscillator and I denote the image frequency (in kHz) of the incoming signal. If the receiver is tuned to 700 kHz, then

- (a) $R = 4.41, I = 1600$
(b) $R = 2.10, I = 1150$
(c) $R = 3.0, I = 1600$
(d) $R = 9.0, I = 1150$

- Q.3 When a radio receiver is tuned to 555 kHz, its local oscillator provides the mixer with an input at 1010 kHz. At the output, another signal is also received along with the desired signal. What is the frequency of the other station?
(a) 910 kHz (b) 355 kHz
(c) 455 kHz (d) 1465 kHz

- Q.4 Match List-I (Modulation/reception techniques) with List-II (Disadvantages) and select the correct answer:

List-I

- A. Superheterodyne receiver
B. FM
C. PCM
D. Delta modulation

List-II

1. Threshold effect
2. Granular noise
3. Image frequency interference
4. Quantization noise

Codes:

	A	B	C	D
(a)	1	3	4	2
(b)	3	1	4	2
(c)	1	3	2	4
(d)	3	1	2	4

- Q.5 One of the main functions of RF stage amplifier in Super Heterodyne Radio Receiver is to
(a) provide improve tracking.
(b) permit better adjacent channel rejection.
(c) increase tuning range of the receiver.
(d) improve rejection of image frequency.

- Q.6 In a superheterodyne receiver arrange the following components sequentially from input to the output:

1. Antenna 2. Mixture
3. IF amplifier 4. Audio amplifier
(a) 1, 2, 3 and 4 (b) 4, 2, 3 and 1
(c) 1, 3, 2 and 4 (d) 4, 3, 2 and 1

- Q.7 The image channel rejection in a superheterodyne receiver comes from
(a) IF stages only
(b) RF stages only
(c) Detectors and RF stages only
(d) Detector, RF and IF stages

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Q.1 In a PCM system each quantisation level is encoded into 8 bits. The signal to quantisation noise ratio is equal to

- (a) $\frac{1}{12} \left(\frac{1}{256} \right)^2$ (b) 48 dB
(c) 64 dB (d) 256 dB

Q.2 A band-pass signal has significant frequency components in the range of 1.5 MHz to 2 MHz. If the signal is to be reconstructed from its samples, the minimum sampling frequency will be

- (a) 1 MHz (b) 2 MHz
(c) 3.5 MHz (d) 4 MHz

Q.3 Four signals each band-limited to 5 kHz are sampled at twice the Nyquist rate. The resulting PAM samples are transmitted over a single channel after time division multiplexing. The theoretical minimum transmission bandwidth of the channel should be equal to

- (a) 5 kHz (b) 20 kHz
(c) 40 kHz (d) 80 kHz

Q.4 A signal $x(t) = 6\cos 10\pi t$ is sampled at the rate of 14 Hz. To recover the original signal, the cut-off frequency f_c of the ideal low-pass filter should be

- (a) $5\text{ Hz} < f_c < 9\text{ Hz}$ (b) 9 Hz
(c) 10 Hz (d) 14 Hz

Q.5 For 10-bit PCM system, the signal to quantisation noise ratio is 62 dB. If the number of bits is increased by 2, then the signal to quantisation noise ratio will

- (a) increase by 6 dB
(b) increase by 12 dB

- (c) decrease by 6 dB
(d) decrease by 12 dB

Q.6 The input to a linear delta modulator having a step-size $\Delta = 0.628$ is a sine wave with frequency f_m and peak amplitude E_m . If the sampling frequency $f_s = 40$ kHz, the combination of the sine-wave frequency and the peak amplitude, where slope overload will take place is

- | E_m | f_m |
|-----------|-------|
| (a) 0.3 V | 8 kHz |
| (b) 1.5 V | 4 kHz |
| (c) 1.5 V | 2 kHz |
| (d) 3.0 V | 1 kHz |

Q.7 In delta modulation, the slope overload distortion can be reduced by

- (a) decreasing the step size
(b) decreasing the granular noise
(c) decreasing the sampling rate
(d) increasing the step size

Q.8 Which one of the following signals can be applied to a delta modulator whose step size is 0.1 V and sampling frequency is 20π kHz so that no slope overload occurs?

- (a) $2 \sin(1200\pi t)$ (b) $1 \sin(2600\pi t)$
(c) $3 \sin(1000\pi t)$ (d) $4 \sin(400\pi t)$

Q.9 A continuous signal has voltage range -2 V to $+2$ V. If this is quantized to 8 bits, what does the resulting signal have?

- (a) 255 levels of step size $4/255$
(b) 25 levels of step size $4/8$
(c) 8 bits plus 2 levels at -2 and $+2$ volts
(d) 8 bits per sample if properly sampled

Q.10 Signal $x(t) = 3\sin 2\pi 10^3 t + 2\sin 2\pi 660 t$. At what sampling frequency should this signal be sampled to avoid aliasing?

- (a) 2×660 Hz
(b) 2×1000 Hz
(c) $2[1000 + 660]$ Hz
(d) $2[1000 - 660]$ Hz

Q.11 An analog signal has significant spectral components from 1 kHz to 5 kHz. What is the Nyquist sampling rate for this signal?

- (a) 5 k samples/s (b) 4 k samples/s
(c) 8 k samples/s (d) 10 k samples/s

Q.12 Four signals $g_1(t)$, $g_2(t)$, $g_3(t)$ and $g_4(t)$ are to be multiplexed and transmitted. $g_1(t)$ and $g_4(t)$ have a bandwidth of 4 kHz, and the remaining two signals have bandwidth of 8 kHz. Each sample requires 8 bit for encoding. What is the minimum transmission bit rate of the system?

- (a) 512 kbps (b) 16 kbps
(c) 192 kbps (d) 384 kbps

Q.13 A 12 channel TDM system where each channel signal is 4 kHz is sampled at 8 kHz. What is the bandwidth requirement?

- (a) 12 kHz (b) 12×4 kHz
(c) 12×8 kHz (d) $12 \times 8 \times 4$ kHz

Q.14 The Nyquist sampling frequency (in Hz) of a signal given by

- $6 \times 10^4 \sin c^3(400t) * 10^6 \sin c^3(100t)$ is
(a) 200 (b) 300
(c) 1500 (d) 1000

Q.15 The peak-to-peak input to an 8-bit PCM coder is 2 volts. The signal power-to-quantization noise power ratio (in dB) for an input of $0.5 \cos(\omega_m t)$ is

- (a) 47.8 (b) 43.8
(c) 95.6 (d) 99.6

Q.16 The Nyquist sampling interval, for the signal $\sin \alpha(700t) + \sin \alpha(500t)$ is

- (a) $\frac{1}{350}$ sec (b) $\frac{\pi}{350}$ sec
(c) $\frac{1}{700}$ sec (d) $\frac{\pi}{175}$ sec

Q.17 A signal $x(t) = 100 \cos(24\pi \times 10^3 t)$ is ideally sampled with a sampling period of 50 μsec and then passed through an ideal lowpass filter with cutoff frequency of 15 kHz. Which of the following frequencies is/are present at the filter output?

- (a) 12 kHz only
(b) 8 kHz only
(c) 12 kHz and 9 kHz
(d) 12 kHz and 8 kHz

Q.18 A sinusoidal signal with peak-to-peak amplitude of 1.536 V is quantized into 128 levels using a mid-rise uniform quantizer. The quantization noise power is

- (a) 0.768 V (b) $48 \times 10^{-6} \text{ V}^2$
(c) $12 \times 10^{-6} \text{ V}^2$ (d) 3.072 V

Q.19 A signal is sampled at 8 kHz and is quantized using 8-bit uniform quantizer. Assuming SNR_q for a sinusoidal signal, the correct statement for PCM signal with a bit rate of R is

- (a) $R = 32$ kbps, $\text{SNR}_q = 25.8$ dB
(b) $R = 64$ kbps, $\text{SNR}_q = 49.8$ dB
(c) $R = 64$ kbps, $\text{SNR}_q = 55.8$ dB
(d) $R = 32$ kbps, $\text{SNR}_q = 49.8$ dB

Q.20 Three analog signals, having bandwidths 1200 Hz, 600 Hz and 600 Hz, are sampled at their respective Nyquist rates, encoded with 12 bit words, and time division multiplexed. The bit rate for the multiplexed signal is

- (a) 115.2 kbps (b) 28.8 kbps
(c) 57.6 kbps (d) 38.4 kbps

Q.21 The minimum sampling frequency (in samples/sec) required to reconstruct the following signal from its samples without distortion

$$x(t) = 5 \left(\frac{\sin 2\pi 1000t}{\pi t} \right)^3 + 7 \left(\frac{\sin 2\pi 1000t}{\pi t} \right)^2$$

would be

- (a) 2×10^3 (b) 4×10^3
(c) 6×10^3 (d) 8×10^3

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Q.20 Four message band limited to ω , ω , 2ω and 3ω respectively are to be multiplexed using TDM. The minimum bandwidth required for transmission of this TDM signal is

- (a) ω (b) 3ω
(c) 6ω (d) 7ω

Q.23 Analog data having highest harmonic at 30 kHz generated by a sensor has been digitized using 6-level PCM. What will be the rate of digital signal generated?

- (a) 120 kbps (b) 200 kbps
(c) 240 kbps (d) 180 kbps

Q.24 The bandwidth of a PCM system having two quantization levels is B . If the quantization level is increased to 8, the resultant bandwidth will be

- (a) B (b) $2B$
(c) $3B$ (d) $4B$

Q.25 The Nyquist sampling rate for the signal $g(t) = 10\cos(50\pi t) \cos^2(150\pi t)$.

Where 't' is in seconds, is

- (a) 150 samples per second
(b) 200 samples per second
(c) 300 samples per second
(d) 350 samples per second

Q.26 What is the condition for which slope overload error occurs in a delta modulation to the input $m(t) = at$ for $t > 0$, where the step size is D and sampling rate is f_s ?

- (a) $\frac{D}{T_s} < \alpha$ (b) $\frac{D}{T_s} > \alpha$
(c) $\frac{D}{T_s} = \alpha$ (d) None of these

■■■■

5

Miscellaneous

Q.1 For a given data rate, the bandwidth B_p of a BPSK signal and the bandwidth B_o of the OOK (on-off keying) signal are related as

- (a) $B_p = B_o/4$ (b) $B_p = B_o/2$
(c) $B_p = B_o$ (d) $B_p = 2B_o$

Q.2 In a digital communication system employing Frequency Shift Keying (FSK), the 0 and 1 bit are represented by sine waves of 10 kHz and 25 kHz respectively. These waveforms will be orthogonal for a bit interval of

- (a) 45 μ sec (b) 200 μ sec
(c) 50 μ sec (d) 250 μ sec

Q.3 For a bit-rate of 8 kbps, the best possible values of the transmitted frequencies in a coherent binary FSK system are

- (a) 16 kHz and 20 kHz
(b) 20 kHz and 32 kHz
(c) 20 kHz and 40 kHz
(d) 32 kHz and 40 kHz

Q.4 A TDM link has 20 signal channels and each channel is sampled at 8 kHz. Each sample is represented by 7 bits and contains an additional bit for synchronization. The total bit rate for the TDM link is

- (a) 1128 kbps (b) 1180 kbps
(c) 1280 kbps (d) 128 Mbps

Q.5 Digital modulation techniques are used in satellite communication system, because

- (a) they are easier to handle
(b) large bandwidth utilization is possible
(c) they have a spectral efficiency
(d) they are less prone to interference

Q.8 Which one of the following modulation technique is most affected by noise?

- (a) ASK (b) PSK
(c) FSK (d) MSK

Q.9 A source deliver symbols x_1 , x_2 , x_3 and x_4 with probabilities 1/2, 1/4, 1/8 and 1/8 respectively. The entropy of the system is

- (a) 1.75 bits per second
(b) 1.75 bits per symbol
(c) 1.75 symbols per second
(d) 1.75 symbols per bit

Q.10 To permit the selection of 1 out of 16 equiprobable events, the number of bits required is

- (a) 2 (b) $\log_{10} 16$
(c) 8 (d) 4

Q.11 A communication channel has a bandwidth of 100 MHz. The channel is extremely noisy such that the signal power is very much below the noise power. What is the capacity of this channel?

- (a) 100 Mbps (b) 50 Mbps
(c) 2400 bps (d) Nearly 0 bps

Q.12 A source produces 26 symbols with equal probability. What is the average information produced by this source?

- (a) < 4 bits/symbol
(b) 6 bits/symbol
(c) 8 bits/symbol
(d) Between 4 and 6 bits/symbol

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- Q.13 A source alphabet consists of N symbols with the probability of the first two symbols being the same. A source encoder increases the probability of the first symbol by a small amount e and decreases that of the second by e . After encoding, the entropy of the source
- (a) increases
 - (b) remains the same
 - (c) increases only if $N = 2$
 - (d) decreases
- Q.14 If the probability of a message is $1/4$, then the information in bits is
- (a) 1 bit
 - (b) 2 bit
 - (c) 4 bit
 - (d) 8 bit
- Q.15 A conventional telephone line with 3 kHz bandwidth and having 30 dB signal-to-noise ratios can carry information at a rate
- (a) of 30 kbps
 - (b) of 15 kbps
 - (c) of 3 kbps
 - (d) of 16 Mbps

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- Q.16 The ratio $\frac{(S/N)_{WBFM}}{(S/N)_{AM}}$ for 100% amplitude modulation with identical total transmitted power (m_f is modulation index of FM) is
- (a) $9/2m_f^2$
 - (b) $3/2m_f^2$
 - (c) $3/2m_f^3$
 - (d) $9/2m_f^3$
- Q.17 S_i and S_o denote the signal at input and output of a linear network N_i and N_o are the corresponding noises. Which one of the following is the correct expression for noise figure of the network?
- (a) $\frac{S_i S_o}{N_i N_o}$
 - (b) $\frac{S_i N_i}{S_o N_o}$
 - (c) $\frac{S_i N_o}{S_o N_i}$
 - (d) $\frac{S_o N_o}{S_i N_i}$

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2017

MADE EASY WORKBOOK

Communication Systems + Electrical Materials + Computer Fundamentals

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OOOO

1

Crystalline Structures



Multiple Choice Questions

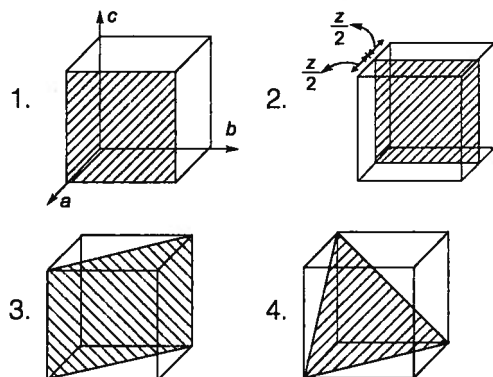
- Q.1 The difference between the number of atoms in a unit cell of a BCC crystal and an FCC crystal is
(a) 1 (b) 2
(c) 4 (d) 6

[ESE (EC) : 2000]

- Q.2 When BCC iron is heated, it changes to FCC iron resulting in
(a) contraction in volume
(b) increase in volume
(c) no change in volume
(d) crack in the material

[ESE (EC) : 2002]

- Q.3 Consider the following crystallographic planes (shaded) using a cube of size z as shown in the diagram:



Which one of the following gives Miller indices of the above planes, in order?

- (a) (100), (200), (100), (111)
(b) (100), (200), (110), (111)
(c) (111), (110), (200), (100)
(d) (200), (111), (110), (100)

[ESE (EC) : 2004]

- Q.4 Consider the following statements in respect of graphite:

1. It has three coplanar covalent bonds.
2. It has good electrical and thermal conductivity.
3. Sheets of graphite are held together by Vander Waal's interaction.

Which of the statements given above are correct?

- (a) 1, 2 and 3 (b) 1 and 2
(c) 2 and 3 (d) 1 and 3

[ESE (EC) : 2005]

- Q.5 **Assertion (A):** In diamond, carbon atoms are packed in a manner so as to give rise to a very low packing efficiency.

Reason (R): Carbon atoms have low mass number, and hence a smaller radius. Small atoms cannot be packed closely.

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

[ESE (EC) : 2005]

- Q.6 The crystal in which atoms are chemically highly inactive and they do not form compounds with other atoms is

- (a) Ionic crystal
(b) Metal
(c) Valence crystal
(d) Van der Waals crystal

[ESE (EC) : 2010]

- Q.7 The geometrical configuration of one molecule of C_{60} -buckminsterfullerene contains
(a) 12 hexagons & 20 pentagons of Carbon atoms
(b) 20 hexagons & 12 pentagons of Carbon atoms
(c) 20 hexagons & 20 pentagons of Carbon atoms
(d) 12 hexagons & 12 pentagons of Carbon atoms

[ESE (EE) : 2011]



Conventional Questions

- Q.8 Draw sketches illustrating a (100) plane, a (110) plane, and a (111) plane in a cubic unit cell. How many equivalent (100) planes are there in a cubic crystal? A material has a face-centred cubic structure with an ionic radius of $1.06 \text{ \AA}$. Calculate the inter planar separation for (111) planes.



Try Yourself

- T1. Match List-I (Atoms) with List-II (Corresponding Cubic Crystal Structure) and select the correct answer using the codes given below the lists:

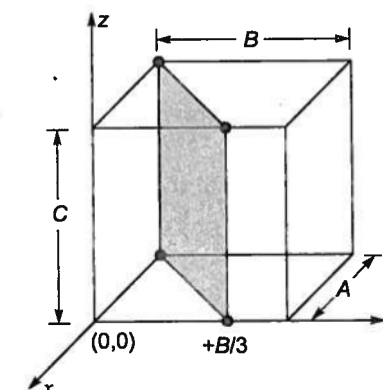
List-I	List-II
A. Silicon	1. Simple cubic structure
B. Gold	2. Body centred cubic structure

- C. Magnesium 3. Face centred cubic structure
D. Magnese 4. Diamond cubic structure
5. Hexagonal closed packing

Codes:

	A	B	C	D
(a)	4	3	5	1
(b)	3	4	2	5
(c)	1	2	3	4
(d)	5	3	4	2

- T2. Miller indices of the shaded figure in structure given below is



- (a) $+A, \frac{B}{3}, C$ (b) $-1, \frac{1}{3}, \infty$
(c) $-A, \frac{B}{3}, \infty$ (d) $-1, 3, 0$



Multiple Choice Questions

Q.1 Assertion (A) : A uniaxial stress on the ends of a piezoelectric crystal develops a potential difference between the two ends of the crystal.
Reason (R) : The ions in the crystal get displaced and produce dipoles.

- (a) Both A and R are true and R is the correct explanation of A
 (b) Both A and R are true but R is NOT the correct explanation of A
 (c) A is true but R is false
 (d) A is false but R is true [ESE (EC) : 1999]

Q.2 A material has an atomic density of 5×10^{28} atoms/m³. Each atom has polarizability 10^{-40} Fm². The internal field when external field of 1 V/m is applied will be

- (a) 1 Volt/m (b) 1.23 Volt/m
 (c) 5 Volt/m (d) 50 Volt/m

Q.3 When a dielectric is subjected to an alternating electric field of angular frequency ' ω ', its power loss is proportional to

- (a) ω (b) ω^2
 (c) $1/\omega$ (d) $1/\omega^2$

[ESE (EE) : 2001]

Q.4 Which of the following statements are correct for ceramic materials?

1. They are inorganic substances
2. They are brittle
3. They are good thermal insulators

Select the correct answer using the codes given below:

- (a) 1, 2 and 3 (b) 1 and 2
 (c) 2 and 3 (d) 1 and 3

[ESE (EC) : 2001]

Q.5 In a material characterized by a complex permittivity, the imaginary part is a measure of
 (a) dielectric strength of the material
 (b) energy stored in the electric field
 (c) losses in the material
 (d) energy stored in the magnetic field

[ESE (EC) : 2002]

Q.6 Amplification of ultrasonic waves is possible in a piezoelectric semiconductor under applied electric field. The basic phenomenon involved is known as

- (a) Electrostriction
 (b) Acousto-optic interaction
 (c) Acousto-electric interaction
 (d) Stimulated Brillouin scattering

[ESE (EC) : 2002]

Q.7 The frequency dependence of electronic polarizability of a dielectric is obtained by solving the equation:

$$m\ddot{x} = -ax - 2b\dot{x} - 2E_0 \cos \omega t$$

Consider the following statements:

In this equation,

1. a is the restoring force constant, the expression for which is obtained from Coulomb's law
2. m is the combined mass of electrons and nucleus
3. b is the damping constant occurring due to emission of electromagnetic radiation
4. $m\ddot{x}$ term arises due to altered velocity of electrons orbit in the nucleus in presence of field.

Which of the above statements are correct?

- (a) 1 and 2 (b) 1 and 3
 (c) 1, 2 and 4 (d) 2, 3 and 4

[ESE (EC) : 2002]

Q.8 A solid specimen of dielectric has

$$\epsilon' = 4.2, \tan \delta = 0.001 \text{ and } f = 50 \text{ Hz.}$$

If it is subjected to an electric field of 50 kV/cm rms value, then the heat generated in specimen due to dielectric loss is

- (a) 0.29 mW/cm³ (b) 4.2 mW/cm³
 (c) 10 mW/cm³ (d) 50 mW/cm³

Q.9 The losses in a dielectric subject to an alternating electric field are determined by

- (a) Real part of the complex dielectric constant
 (b) Imaginary part of the complex dielectric constant
 (c) Absolute value of the complex dielectric constant
 (d) Ratio of the magnitudes of the real and imaginary parts of the complex dielectric constant

[ESE (EE) : 2003]

Q.10 Under the influence of an external electric field an insulator undergoes the process of polarization. There are four contributing factors to the total polarization viz. electronic, ionic, orientational and space charge. At the optical frequencies, the only contribution to total polarization is from

- (a) Space charge polarization
 (b) Ionic polarization
 (c) Orientational polarization
 (d) Electronic polarization [ESE (EC) : 2003]

Q.11 Which one of the following statements is not correct?

- (a) Vacuum can act as a dielectric material
 (b) Piezoelectric materials can act as transducers
 (c) Quartz crystal is a ferroelectric material
 (d) The dielectric constant of dielectrics depends on the frequency of the applied field

[ESE (EE) : 2004]

Q.12 Consider the following statements:

In a ferroelectric material

1. all domains are lined up in the direction of applied field giving rise to saturation
2. if the field is reduced to zero, many domains remain aligned
3. the remanent polarisation can be eliminated only if the material is heated above Curie temperature

Which of the statements given above are correct?

- (a) 1, 2 and 3 (b) 2 and 3
 (c) 1 and 3 (d) 1 and 2

[ESE (EC) : 2004]

Q.13 The electric displacement D in a material is expressed as $D = \epsilon E + d.s$ where ϵ is the permittivity, E is the field, s is strain and d is a characteristic constant of the material. Which is this material?

- (a) Metal
 (b) Antiferromagnetic material
 (c) Semiconductor
 (d) Piezoelectric material [ESE (EC) : 2004]

Q.14 Match List-I (Type of Capacitor) with List-II (Characteristic) and select the correct answer using the codes given below the lists:

List-I

- A. Paper
 B. Mica dielectric
 C. Ceramic dielectric
 D. Electrolytic

List-II

1. Low volume for large capacitance
2. Inexpensive
3. Suitable for RF bypass
4. Long-term stability

Codes:

	A	B	C	D
(a)	3	1	2	4
(b)	2	1	3	4
(c)	2	4	3	1
(d)	3	4	2	1

[ESE (EC) : 2004]

Q.15 Assertion (A): At room temperature, in the absence of an external field, a barium titanate ferroelectric crystal exhibits no polarisation.

Reason (R): There are no dipoles in this crystal at room temperature in the absence of an external field.

- (a) Both A and R are true and R is the correct explanation of A
 (b) Both A and R are true but R is NOT the correct explanation of A
 (c) A is true but R is false
 (d) A is false but R is true [ESE (EC) : 2004]

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Q.16 The number of dipoles in volume of 1 m^3 of hydrogen gas is 9.8×10^{26} . Radius of H atom is $0.53 \text{ \AA}$. The electronic polarizability of the material is

- (a) 5.778×10^{-40} (b) 1.09×10^{-41}
(c) 1.656×10^{-41} (d) 3.062×10^{-40}

Q.17 How much (approximate) is the frequency independent power factor of a plastic dielectric capacitor?

- (a) 0.00002 (b) 0.0002
(c) 0.002 (d) 0.02

[ESE (EC) : 2007]

Q.18 Which one of the following is not a characteristic of a ferroelectric material?

- (a) High dielectric constant
(b) No hysteresis
(c) Ferroelectric characteristic only above the Curie point
(d) Electric dipole moment

[ESE (EC) : 2007]

Q.19 The resonance frequency of a quartz crystal oscillator shows least variation with temperature when the orientation of the crystal is chosen to have

- (a) X-cut (b) Y-cut
(c) NT-cut (d) AT-cut

[ESE (EC) : 2009]

Q.20 The electronic polarisability of an inert gas atom is proportional to which one of the following?

- (a) R (b) R^2
(c) R^3 (d) R^4

(Where R is the radius of the atom)

[ESE (EE) : 2008]

Q.21 The following properties are associated with ferroelectric materials :

1. Its susceptibility is negative.
2. The susceptibility is expressed as

$$\chi = \frac{C}{T - T_c} \text{ where } C \text{ is the Curie constant}$$

and T_c is the Curie temperature.

3. It has permanent dipoles oriented randomly.

Which of the above statements is/are correct?

- (a) 1 only (b) 1 and 3
(c) 2 only (d) 1, 2 and 3

[ESE (EC) : 2009]

Q.22 Statement (I): The dielectric constant of a substance, under the influence of alternating electric fields is, in general, a 'complex' quantity.

Statement (II): The 'imaginary' part of the dielectric constant is a measure of the dielectric loss in the substance.

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

[ESE (EE) : 2013]

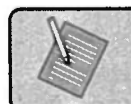
Q.23 Consider the following statements related to piezoelectric effect:

1. It gives electrical response in terms of voltage change when mechanical stress occurs in some materials
2. It gives mechanical response in terms of dimensional change due to electrical excitation of some materials

Which of the above statements is/are correct?

- (a) 1 only
(b) 2 only
(c) Neither 1 nor 2
(d) Both 1 and 2

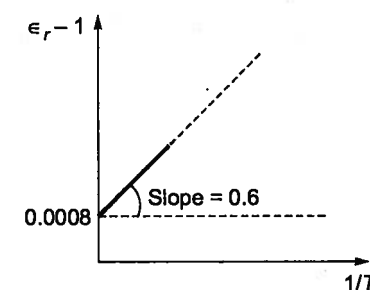
[ESE (EC) : 2015]



Conventional Questions

Q.24 Consider a solid containing N identical atoms per m^3 , the polarizability of which is α farad m^2 . Assuming a Lorentz internal field, derive the Clausius-Mosotti relation.

Q.25 The variations of dielectric constant of nitrobenzene as a function of temperature are given in figure below.



Calculate the value of permanent dipole moment if the number of molecules/ cm^3 is $2.5 \times 10^{25}/\text{m}^3$.

Q.26 A homogeneous slab of dielectric material is characterized by a dielectric susceptibility of 0.12 and carries uniform flux density within it of 1.6 C/m^2 . Find E , P , p and voltage across dielectric if there are 2×10^9 dipoles/cubic meter a distance between opposites surfaces of dielectric is 2.54 cm .



Try Yourself

T1. The imaginary part of dielectric constant determines

- (a) component of current which is in phase with the applied field
(b) component of energy absorbed per m^3
(c) amount of applied field
(d) component of voltage which is in phase with the applied field

[ESE (EE) : 2014]

T2. A barium titanate crystal has a thickness of 2 mm . Its voltage sensitivity is $12 \times 10^{-3} \text{ Vm/N}$. It is subjected to a pressure of 0.5 MN/m^2 . What is the voltage generated?

- (a) 3 V (b) 6 V
(c) 5 V (d) 12 V

T3. There are 10^{27} HCL molecules per cubic meter in a vapour. Determine the orientational polarisation at room temperature if the vapour is subjected to an electrical field of 10^6 V/m . The permanent dipole moment of HCL molecule being 1.04 debye unit.

1 debye unit = $3.33 \times 10^{-30} \text{ Coulomb-metre}$

- (a) $0.875 \times 10^{-38} \text{ Farad-metre}^2$
(b) $0.875 \times 10^{-39} \text{ Farad-metre}^2$
(c) $0.966 \times 10^{-39} \text{ Farad-metre}^2$
(d) $0.966 \times 10^{-6} \text{ Coulomb-metre}^2$

T4. The real parts of the relative dielectric constant and loss tangent of teflon are 2.1 and 5×10^{-4} at 100 Hz respectively. The imaginary part of the dielectric constant at 100 Hz is

- (a) 1.05×10^{-3} (b) 2.1×10^{-3}
(c) 5×10^{-3} (d) 1.05×10^{-2}

T5. Consider the following statements regarding an insulating material connected to an a.c. signal:

1. The dielectric constant increases with frequency
2. The dielectric constant decreases with frequency
3. Atomic polarization decreases with frequency

Which of these statement(s) is/are correct?

- (a) 3 alone (b) 2 alone
(c) 2 and 3 (d) 1 and 3

T6. Consider the following statements:

- An insulating material shows polarization due to charged atoms. Its polarizability
1. decrease with applied electric field.
 2. remains independent of temperature at a given field.
 3. increases with applied electric field at constant temperature.

Which of the statement(s) given above is /are correct?

- (a) 1 only (b) 1 and 2 only
(c) 3 only (d) 2 and 3 only

3

Magnetic Properties of Materials



Multiple Choice Questions

Q.1 The magnetic moment in units of Bohr magneton of a ferrous ion in any ferrite is

- (a) zero (b) 2
(c) 4 (d) 6

[ESE (EC) : 1999]

Q.2 Match List-I (Magnetic materials) with List-II (Dipole arrangement in external field) and select the correct answer using the codes given below the lists:

List-I

- A. Paramagnetic
B. Ferromagnetic
C. Antiferromagnetic
D. Ferrimagnetic

List-II

- All dipoles are aligned in one preferred direction and have equal magnitudes
- Half of the dipoles are aligned in opposite direction and have equal magnitudes
- Half of the dipoles (with equal magnitudes) are aligned in opposite direction to other half having equal but lower magnitudes
- All dipoles have equal magnitudes but are randomly oriented

Codes:

	A	B	C	D
(a)	4	3	2	1
(b)	4	1	2	3
(c)	2	1	4	3
(d)	2	3	4	1

[ESE (EC) : 2000]

Q.3 The outermost electronic configuration of a cobalt atom is $3d^7 4s^2$. Its magnetic moment is

(a) 9 Bohr magnetons
(b) 7 Bohr magnetons
(c) 5 Bohr magnetons
(d) 3 Bohr magnetons [ESE (EC) : 2001]

Q.4 A magnetic material has a magnetization of 3300 A/m and flux density of 0.0044 W/m². The relative permeability of material is

(a) 2.8 (b) 9.33
(c) 17.26 (d) 33

Q.5 **Assertion (A):** Resistivity of ferrites is very much lower than that of ferromagnetic materials.
Reason (R): Ferrites are chemical compounds and the electrons in them are subject to the restraint of valence forces.

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true [ESE (EC) : 2004]

Q.6 Which one of the following is the temperature below which certain material are anti-ferromagnetic and above which they are paramagnetic?

- (a) Curie temperature
(b) Neel temperature
(c) Transition temperature
(d) Weiss temperature

[ESE (EE) : 2004]

Q.7 Which one of the following statements is correct? A ferrite core has lower specific eddy current loss compared to an iron core because the iron core has

- (a) higher electrical resistance
(b) lower electrical resistance
(c) higher permeability
(d) lower permeability

[ESE (EE) : 2004]

Q.8 **Assertion (A):** Soft magnetic material is used in making electromagnets.

Reason (R): Soft magnetic materials have a high coercive field.

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

[ESE (EE) : 2004]

Q.9 The magnetic field required to reduce the residual magnetisation to zero is called

- (a) Retentivity
(b) Coercivity
(c) Hysteresis
(d) Saturation magnetisation

[ESE (EE) : 2005]

Q.10 Which material is used for making permanent magnet?

- (a) Carbon steel
(b) Germanium
(c) Silicon
(d) None of the above

[ESE (EC) : 2007]

Q.11 Consider the following statements:

- At finite temperature, magnetic dipoles in a material are randomly oriented giving low magnetization. When magnetic field H is applied, the magnetization
- increases with H
 - decreases with H
 - decreases with temperature for constant H

Which of the statement(s) given above is/are correct?

- (a) 1 only (b) 2 only
(c) 2 and 3 (d) 1 and 3

[ESE (EC) : 2007]

Q.12 Consider the following statements about diamagnetic materials and diamagnetism:

- The materials have negative magnetic susceptibility
- At very low temperatures diamagnetic materials are converted into paramagnetic materials

Which of the statements given above is/are correct?

- (a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

[ESE (EC) : 2007]

Q.13 At finite temperature magnetic dipoles in a materials are randomly oriented giving low magnetization. When magnetic field is applied, the magnetization

- (a) increases with field intensity
(b) decreases with field intensity
(c) decreases with temperature for constant field intensity
(d) increases with temperature for constant field intensity

Q.14 Ferromagnetic materials show hysteresis in $B-H$ characteristic. As the magnetic field is increased slowly from zero value, what is the first process which sets in the material to give net magnetization?

- (a) Growth of favourably oriented domains at the cost of other domains by reversible boundary displacements
(b) Growth of favourably oriented domains at the cost of other domains by irreversible boundary displacements
(c) Domain wall orientation
(d) A combination of processes (a) and (c) above

[ESE (EC) : 2009]

Q.15 A material shows spontaneous magnetization. This is due to

1. Weiss molecular field.
2. Cooperative effect among dipoles.
3. Cooperative effect among domains.
4. Absence of applied magnetic field.

Which of these statements are correct?

- (a) 1, 2, 3 and 4 (b) 2, 3 and 4 only
(c) 1, 2 and 3 only (d) 1, 2 and 4 only

[ESE (EC) : 2011]

Q.16 Consider the following statements:

The coercive force can be increased by

1. Adding Cobalt because it is ferro-magnetic material.
2. Adding Gold because it is a diamagnetic material.
3. Adding Super alloy.
4. Space charge polarizing.

Which of the above statements is/are correct?

- (a) 1, 2, 3 and 4 (b) 1 only
(c) 2 only (d) 1 and 3 only

[ESE (EE) : 2010]

Q.17 How can eddy current loss in the core of transformer be minimized?

1. By increasing resistivity of core.
2. By using lamination of insulator.
3. By using highly insulating non magnetic material for the core.
4. By using paramagnetic material for the core.

Which of the given statement/s is/are correct?

- (a) 1 only (b) 1 and 2
(c) 1 and 3 (d) 2, 3 and 4

Q.18 **Statement (I):** All substances except ferromagnetic materials which can form permanent magnets, exhibit magnetic effects.

Statement (II): The magnetic effect is due to alignment of dipoles when subjected to an external electromagnetic field.

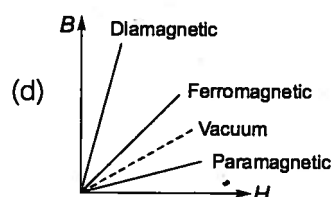
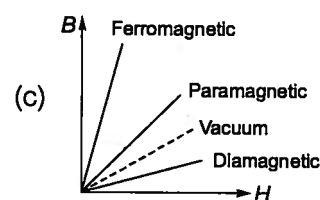
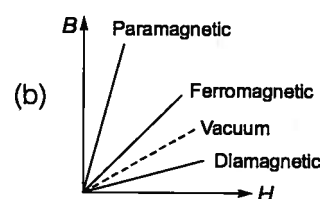
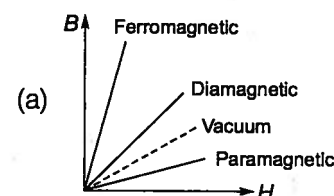
- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).

(c) Statement (I) is true but Statement (II) is false.

(d) Statement (I) is false but Statement (II) is true.

[ESE (EC) : 2012]

Q.19 The dependence of B (flux density) on H (magnetic field intensity) for different types of materials is



[ESE (EE) : 2012]

Q.20 As per Curie-Weiss law, the magnetic susceptibility of a material varies as

- (a) T^{-2} (b) $1/T$
(c) T (d) T^2

[ESE (EC) : 2013]

Q.21 The relationship between relative permeability (μ_r) and magnetic susceptibility (χ) of the medium is

- (a) $\mu_r = 1 + \chi$ (b) $\mu_r = \frac{1}{1 + \chi}$
(c) $\mu_r = 1 - \chi$ (d) $\mu_r = \frac{1}{\chi}$

[ESE (EC) : 2014]

Q.22 Magnetostriction is the effect produced when change of magnetization in magnetic material results in

- change of permeability
- change in dimensions
- change of temperature
- change of magnetic field strength

[ESE (EC) : 2014]

Q.23 **Statement (I):** Ferrite cored coils are used in high frequency tuned circuits.

Statement (II): Ferrite cored coils have high Q as compared to iron-cored coils.

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is NOT the correct explanation of Statement (I)
(c) Statement (I) is true but Statement (II) is false
(d) Statement (I) is false but Statement (II) is true

[ESE (EC) : 2015]

Q.24 The evidence for the importance of electron-phonon interaction in superconductors comes from

- Meissner effect
- Josephson effect
- isotope effect
- flux quantization experiments

[ESE (EE) : 2015]

Q.25 For high-speed reading and storing of information in a computer, the material used is

- ferrite
- piezoelectric
- pyroelectric
- ferromagnetic above 768°C

[ESE (EE) : 2015]



Conventional Questions

Q.26 What is the domain theory of magnetization? What is Curie temperature? Can Curie temperature of a material be changed?

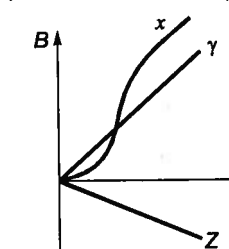
Q.27 (i) What is a soft magnetic material? Give examples of soft magnetic materials and list their applications.

(ii) With the help of magnetization characteristics (M vs B curves) explain the difference between Type-I and Type-II superconductors.



Try Yourself

T1. Three B-H curves are shown in the figure. The curves X, Y and Z refer respectively to

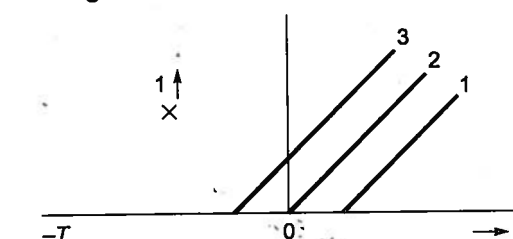


- diamagnet, paramagnet and ferromagnet
- paramagnet, ferromagnet and diamagnet
- ferromagnet, diamagnet and paramagnet
- ferromagnet, paramagnet and diamagnet

T2. The phenomenon by which a ferromagnetic material is magnetized to its final state by a magnetic field is attributed to

- eddy currents and magnetic viscosity
- magnetic viscosity and hysteresis
- hysteresis and eddy currents
- ageing and magnetic viscosity

T3. Temperature (T) dependence of the reciprocal of susceptibilities of three different magnetic materials, 1, 2 and 3 is shown in the given figure. Among these materials spontaneous magnetisation will be shown by



- 2 alone
- 2 and 3
- 1 and 3
- 1, 2 and 3

T4. A paramagnetic system of electronic spins is subjected to H -field = 10^6 A/m at 300 K. Find the average magnetic moment along H -direction per spin in Bohr magneton. What is its value at 4.2 K?

T5. A bar magnet made of steel has a magnetic moment of 2.5 A-m^2 and a mass of 6.6×10^3 kg. If the density of steel is $7.9 \times 10^3 \text{ kg/m}^3$, the intensity of magnetization is

- (a) 8.3 A/m (b) 3 A/m
(c) 6.3 A/m (d) 9.2 A/m

T6. For a permanent magnetic material
(a) the residual induction and the coercive field should be large
(b) the residual induction and the coercive field should be small
(c) the area of hysteresis loop should be small
(d) the initial relative permeability should be large

T7. Match List-I with List-II and select the correct answer using the code given below the lists:

List-I

- A. No eddy current loss
B. Small hysteresis loss
C. Large hysteresis loss

List-II

1. Ferrimagnetic material
2. Soft magnetic material
3. Hard magnetic material
4. Non-ferrous material

Codes:

	A	B	C
(a)	2	1	3
(b)	2	3	4
(c)	1	3	4
(d)	1	2	3

T8. In a specimen of silicon steel, a field strength of 200 A/m causes a flux density of 0.5 T. In a specimen of cast iron, the same H would cause B to be
(a) 0.5 T
(b) less than 0.5 T
(c) more than 0.5 T
(d) 0.5 T or more or less

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4

Conductive Materials & Superconductors



Multiple Choice Questions

Q.1 The magnetization ' M ' of a superconductor in a field of H is

- (a) extremely small (b) $-H$
(c) -1 (d) zero

[ESE (EC) : 1999]

Q.2 Which one of the following is the best definition of a superconductor?

- (a) It is a material showing perfect conductivity and Meissner effect below a critical temperature
(b) It is a conductor having zero resistance
(c) It is a perfect conductor with highest diamagnetic susceptibility
(d) It is a perfect conductor but becomes resistive when the current density through it exceeds a critical value

[ESE (EC) : 2000]

Q.3 The conductivity of a superconducting material on being subject to critical magnetic field changes to

- (a) normal state
(b) unstable state
(c) temperature-independent state
(d) temperature-dependent state

[ESE (EE) : 2001]

Q.4 When copper is added to silver in small quantity so as to form an alloy, the resistivity of such an alloy is

- (a) equal to the resistivity of copper
(b) equal to the resistivity of silver
(c) greater than the resistivity of copper
(d) in between the resistivities of silver and copper

[ESE (EC) : 2002]

Q.5 A resistance thermometer has a temperature coefficient of resistance 10^{-3} per degree and its resistance at 0°C is 1.0Ω . At what temperature is its resistance 1.1Ω ?

- (a) 10°C (b) 100°C
(c) 120°C (d) -10°C

[ESE (EC) : 2003]

Q.6 Why does the electric conductivity of a solid solution alloy drop off rapidly with an increased alloy content?

- (a) Because the solid solution has a dielectric nature
(b) Because the solid solution has a less regular structure than that of a pure metal
(c) Because the solid solution has a higher conductivity than that of the alloying material
(d) Because the solid solution has a lower molecular weight

[ESE (EC) : 2004]

Q.7 A thin resistive film having length (l), width (w) and thickness (t) is used as a resistor (R_1) for conducting current in the direction of l . If the film is connected to serve as a resistor (R_2) for conducting current in the direction of w , then what is the value of R_1/R_2 ?

- (a) l/w (b) w/l
(c) l^2/w^2 (d) w^2/l^2

[ESE (EC) : 2005]

Q.8 What is the correct arrangement of the following alloys in decreasing order of resistivity?

- (a) German silver - constantan - monel metal
(b) German silver - monel metal - constantan
(c) Constantan - monel metal - German silver
(d) Constantan - German silver - monel metal

[ESE (EC) : 2006]

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Q.9 Consider the following statements in connection with superconductors:

1. Transition temperature of a super-conductor can be reduced by the application of a magnetic field.
2. Transition from the superconducting to normal state under the influence of a magnetic field is irreversible.

Which of these statements is/are correct?

- (a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

[ESE (EE) : 2007]

Q.10 Two materials having temperature coefficient of 0.004 and 0.0004 respectively are joined in series. The overall temperature coefficient is approximately

- (a) 0.08 (b) 0.04
(c) 0.001 (d) 0.0001

[ESE (EE) : 2008]

Q.11 Which of the following statements is/are true for a good conductor of electricity?

1. Its conductivity decreases with increasing temperature.
2. Number of free electrons is around 10^{28} m^{-3}
3. Its conductivity decreases with addition of impurities.
4. It is a good conductor of heat also.

Select the correct answer using the codes given below:

- (a) 1, 2, 3 and 4 (b) 1 only
(c) 2 and 3 only (d) 3 and 4 only

[ESE (EC) : 2009]

Q.12 The fuse material used in electrical lines must have which one of the following properties?

- (a) High resistivity
(b) Low conductivity
(c) High melting point
(d) Low melting point

[ESE (EC) : 2009]

Q.13 Intense magnetic field may be produced in a coil by using a

- (a) Normal metal with a large number of turns and sending a large current
(b) Type-I superconductor with a large number of turns and sending a large current

(c) Type-II superconductor with a large number of turns and sending a large current

(d) Type-II superconductor with a large number of turns but limiting the current density below a critical value

[ESE (EC) : 2011]

Q.14 Critical field for Niobium is given by $1 \times 10^5 \text{ A/m}$ at 8°K and $2 \times 10^5 \text{ A/m}$ at 0°K . The critical temperature T_c is

- (a) 5.656°K (b) 11.28°K
(c) 17.69°K (d) 35.17°K

Q.15 Statement (I): In Ferroelectric materials domains with permanent electric dipoles may be created that would align along external electric field.

Statement (II): Ferroelectric materials undergo phase transformation of symmetric to asymmetric structure below a critical temperature.

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is NOT the correct explanation of Statement (I)
(c) Statement (I) is true but Statement (II) is false
(d) Statement (I) is false but Statement (II) is true

[ESE (EC) : 2015]

Q.16 Which effect is the converse of Peltier effect?

- (a) Seebeck effect (b) Thomson effect
(c) Hall effect (d) Joule effect

[ESE (EE) : 2015]



Conventional Questions

Q.17 What are the factors that will increase the dielectric loss in dielectric materials?

What properties should the insulating materials have to avoid breakdown?

What are the important applications of insulating materials?

Q.18 What are superconductors? Explain the Meissner effect. Show that perfect diamagnetism and zero resistivity are two independent properties of the superconducting state.

Q.19 Certain metal works as superconductor below the critical temperature $T_c = 7.2^\circ\text{K}$. The critical magnetic field for the metal at 0°K is $7.8 \times 10^5 \text{ Amp/m}$. What is the critical magnetic field for the metal to be usable as superconductor at 5°K ?

Q.20 What are the expressions for series and parallel resonances of the equivalent circuit of a quartz crystal oscillator?



Try Yourself

T1. Match List-I (Magnetic materials) with List-II (Main applications) and select the correct answers using the codes given below the lists :

List-I	List-II
A. Ni-Zn ferrite	1. Recording head
B. Co-Si alloy	2. Permanent Magnets
C. Yttrium Iron transformers	3. Audio & TV Garnet
D. Mg-Zn ferrite	4. Memory cores
	5. Microwave isolators

Codes :

	A	B	C	D
(a)	3	4	5	2
(b)	1	2	3	4
(c)	3	2	5	4
(d)	1	4	3	2

T2. The superconducting transition temperature of lead is 7.26 K . If the initial field at 0 K is $64 \times 10^3 \text{ Amp/m}$, then the critical field at 5 K is

- (a) $0.3364 \times 10^3 \text{ Amp/m}$
(b) $3.364 \times 10^3 \text{ Amp/m}$
(c) $33.640 \times 10^3 \text{ Amp/m}$
(d) $336.400 \times 10^3 \text{ Amp/m}$

T3. A copper wire (diameter = 0.16 cm), carries a current = 10 A . Calculate the drift speed and mean-free path of electrons in the copper metal, if the mean thermal velocity = $1.6 \times 10^6 \text{ m/sec}$ and the resistivity of $\text{Cu} = 2 \times 10^{-8} \text{ ohm-metre}$ at 20°C .

T4. What is the magnetic susceptibility χ of an ideal superconductor?

- (a) 1 (b) -1
(c) 0 (d) Infinite



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OOOO

Computer Fundamentals Description Sheet

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- Functionality of the computer

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 - Accumulator CPU
 - General Register CPU
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- Instruction cycle
- Instruction types and Addressing modes
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- Control unit design, Micro-operations and Microprograms

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- Types of OS and goals of OS
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- Element of programming languages
- Fundamentals of C-language

■■■■



Multiple Choice Questions

Q.1 The most relevant addressing mode to write position independent codes is

- (a) Direct mode (b) Indirect mode
(c) Relative mode (d) Indexed mode

[GATE-1987]

Common Data for Questions (2 and 3):

Consider the following assembly language program for a hypothetical processor. A, B and C are 8-bit registers. The meanings as various instructions are shown as comments.

```

MOV B, #0; B ← 0
MOV C, #8; C ← 8
Z: CMP C, #0; Compare C with 0
   JZ X; Jump to X if zero flag is set
SUB C, #1; C ← C - 1
RRC A, #1; Rotate right A through carry by one bit.
JC Y; Jump to Y if carry flag is set
JMP Z; Jump to Z
Y: Add B, #1; B ← B + 1
JMP Z; Jump to Z
X:

```

Q.2 If the initial value of register A is A_0 . The value of register B after the program execution will be

- (a) The number of '0' bits in A_0
(b) The number of '1' bits in A_0
(c) A_0
(d) 8

[GATE-2003]

Q.3 Which of the following instructions when inserted at location X will ensure that the value of register A after program execution is the same as its initial value

- (a) RRC A, #1; Rotate right A through carry
(b) NOP; No operation
(c) LRC A, #1; Left rotate A through carry
(d) ADD A, #1; $A \leftarrow A + 1$

[GATE-2003]

Q.4 Which of the following addressing modes are suitable for program relocation at run time

1. Absolute addressing
2. Based addressing
3. Relative addressing
4. Indirect addressing

Common Data for Questions (5 to 6):

Solve the problems and choose the correct answers. Consider the following program segment for a hypothetical CPU having three user registers R_1 , R_2 and R_3

Instruction	Operation	Instruction size (words)
MOV R_1 , 5000;	$R_1 \leftarrow M[5000]$	2
MOV R_2 , (R_1);	$R_2 \leftarrow M[[R_1]]$	1
ADD R_2 , R_3 ;	$R_2 \leftarrow R_2 + R_3$	1
MOV 6000, R_2 ;	$M[6000] \leftarrow R_2$	2
Halt;	Machine Halts	1

Q.5 Consider that the memory is byte addressable with word size 32 bits, and the program has been loaded starting from memory location 1000 (decimal). If an interrupt occurs when the CPU has been halted after executing the Halt instruction, the return address saved in the stack will be

- (a) 1007 (b) 1020
(c) 1024 (d) 1028

[GATE-2004]

Q.6 Let the clock cycles required for various operations be as follows:
Register to/from memory transfer: 3 cycles
Add with both operands in registers : 1 cycle
Instruction fetch and decode: 2 cycle per word
The total cycles required to execute the program is

- (a) 29 (b) 24
(c) 23 (d) 20

[GATE-2004]

Q.7 A CPU has 24-bit instructions. A program starts at address 300 (in decimal). Which one of the following is a legal program counter (all values in decimal)

- (a) 400 (b) 500
(c) 600 (d) 700

[GATE-2005]

Q.8 If we use internal data forwarding to speed up the performance of a CPU (R_1 , R_2 and R_3) are registers and $M[100]$ is a memory reference) then the sequence of operations.

 $R_1 \rightarrow M[100]$ $M[100] \rightarrow R_2$ $M[100] \rightarrow R_3$ can be replaced by

(a) $R_1 \rightarrow R_3$ (b) $M[100] \rightarrow R_2$
 $R_2 \rightarrow M[100]$ $R_1 \rightarrow R_2$

 $R_1 \rightarrow R_3$

(c) $R_1 \rightarrow M[100]$ (d) $R_1 \rightarrow R_2$, $R_1 \rightarrow R_3$
 $R_2 \rightarrow R_3$ $R_1 \rightarrow M[100]$

[GATE-2004]

Q.9 In which addressing mode the effective address of the operand is generated by adding a constant value to the content of a register?

- (a) Absolute mode
(b) Indirect mode
(c) Immediate mode
(d) Index mode

[ISRO-2009]

Q.10 While an instruction is executed the program counter should contain the address to

- (a) the current instruction
(b) the next sequential instruction
(c) the operand
(d) the previous instruction [DRDO-2009]

Q.11 Compared to CISC processors, RISC processor contain

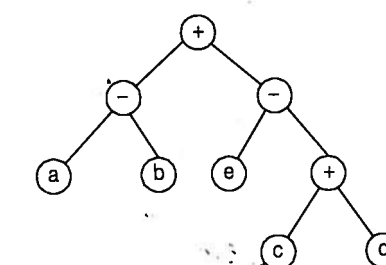
- (a) More register and smaller instruction set
(b) Larger instruction set and less register
(c) Less registers and smaller instruction set
(d) More transistor elements

[ISRO-2009]

Q.12 A computer has 256 K word memory. The instruction format has four fields i.e., OP-CODE, register field to represent one of the 60 processor registers, mode field represents one of 7 addressing modes and memory address field. How many instructions the system supports when a 32-bit instruction is placed in the one memory cell.

- (a) 32 (b) 64
(c) 24 (d) 2^{32}

Q.13 Consider evaluating the following expression tree on a machine with load-store architecture in which memory can be accessed only through load and store instructions. The variables a, b, c, d and e are initially stored in memory. The binary operators used in this expression tree can be evaluated by the machine only when the operands are in registers. The instructions produce result only in a register. If no intermediate results can be stored in memory. What is the minimum number of registers needed to evaluate this expression.



- (a) 4 (b) 3
(c) 2 (d) 5

[GATE-2011]

Q.14 A machine has a 32-bit architecture, with 1-word long instructions. It has 64 registers, each of which is 32 bits long. It needs to support 45 instructions, which have an immediate operand in addition to two register operands. Assuming that the immediate operand is an unsigned integer, the maximum value of the immediate operand is _____.

- (a) 2^{14} (b) $2^{14} - 1$
(c) 2^{13} (d) $2^{13} - 1$

[GATE-2014, Ans: (16383)]

Q.15 A micro programmed control unit
(a) is faster than a hard-wired control unit
(b) facilitates easy implementation of new instructions
(c) is useful when very small programs are to be run
(d) usually refers to the control unit of a micro processor

[GATE-1987]

Q.16 A typical vertical micro instruction format is characterized by

- (a) limited encoding with limited parallelism
(b) limited encoding with high degree of parallelism
(c) high degree of encoding with high degree of parallelism
(d) high degree of encoding with limited parallelism

[DRDO-2009]

Q.17 A micro programmed control memory supports 256 instructions. Every instruction an average consume 8 micro operations. The system supports 16 flag conditions and 48 control signals. If the horizontal micro programming is used, what is the size of each control word let 1 address control instruction is used.

- (a) 61 bits (b) 63 bits
(c) 6 bits (d) 8 bits

[GATE-2008]

Q.18 The control field of 1-address control word has to support 2 groups of control signals. In the group-1 it is requires to generate either 1 or

none of the 63 control signals. In the group-2 at most 4 from the remaining. What will be the minimum number of bits needed for control field.

- (a) 6 (b) 10
(c) 67 (d) 81

Q.19 A hard wired CU uses 10 control signals S_1 to S_{10} in various times steps T_1 to T_5 implement 4 instruction I_1 to I_4 as shown below:

	T_1	T_2	T_3	T_4	T_5
I_1	S_1, S_3, S_5	S_2, S_4, S_6	S_1, S_7	S_{10}	S_3, S_8
I_2	S_1, S_3, S_5	S_8, S_9, S_{10}	S_5, S_6, S_7	S_6	S_{10}
I_3	S_1, S_3, S_5	S_7, S_8, S_{10}	S_2, S_6, S_9	S_{10}	S_1, S_3
I_4	S_1, S_3, S_5	S_2, S_6, S_7	S_2, S_{10}	S_6, S_9	S_{10}

Which of the following pairs of expressions represent the circuit for generating control signals S_5 and S_{10} respectively.

- (a) $T_1 + T_2 T_3 \& (I_1 + I_3) T_4 + (T_2 + I_4) T_5$
(b) $T_1 + (I_2 + I_4) T_3 \& (I_1 + I_3) T_4 + (I_2 + I_4) T_5$
(c) $T_1 (I_2 + I_4) T_3 \& (I_2 + I_3 + I_4) T_2 + (I_1 + I_3) T_4 (I_2 + I_4) T_5$
(d) $T_1 + I_2 T_3 \& (I_2 + I_3) T_2 + I_4 T_3 + (I_1 + I_3) T_4 + (I_2 + I_4) T_5$

[GATE-2005]

Q.20 A CPU has only three instruction I_1 , I_2 and I_3 . Which uses the following signals in time steps

$T_1 - T_5$

I_1 : T_1 : A_{in} , B_{out} , C_{in}

T_2 : PC_{out} , B_{in}

T_3 : Z_{out} , A_{in}

T_4 : PC_{in} , B_{out}

T_5 : End

I_2 : T_1 : C_{in} , B_{out} , D_{in}

T_2 : A_{out} , B_{in}

T_3 : Z_{out} , A_{in}

T_4 : B_{in} , C_{out}

T_5 : End

I_3 : T_1 : D_{in} , A_{out}

T_2 : A_{in} , B_{out}

T_3 : Z_{out} , A_{in}

T_4 : Z_{out} , A_{in}

T_5 : End.

Which of the following logic functions will generate the hard wired control for the signal

A_{in}

- (a) $T_1 I_1 + T_2 I_3 + T_4 I_3 + T_3$
(b) $(T_1 + T_2 + T_3) I_3 + T_1 I_1$
(c) $(T_1 + T_2) I_1 + (T_2 + T_4) I_3 + T_3$
(d) $(T_1 + T_2) I_2 + (T_1 + T_3) I_1 + T_3$

[GATE-2004]



Try Yourself

- T1.** Horizontal micro programming
(a) does not require use of signal decodes
(b) results in larger sized micro instructions than vertical micro programming
(c) use one bit for each control signal
(d) All of the above

- T2.** The instruction mix in an application and instruction execution speed of a hypothetical machine are shown below:

Instruction	Speed (cycle)	Occurrence (%)
ADD	8	30
SHIFT	4	20
LOAD	12	30
STORE ^z	12	20

If the clock frequency is 2.3 GHz, the machine performance in MIPS is _____.

- (a) 128 (b) 250
(c) 256 (d) 64

T3. An instruction set of a processor has 125 signals which can be divided into 5 groups of mutually exclusive signals.

- Group 1: 20 signals
Group-2: 70 Signals
Group-3: 2 Signals
Group-4: 10 Signals
Group-5: 23 Signals

How many bits of the control word can be saved by using vertical micro programming over horizontal programming

- (a) 28 (b) 103
(c) 108 (d) 64

[GATE-2005]

T4. Consider the following micro program.

T_1 : $MAR \leftarrow PC$

T_2 : $MBR \leftarrow X$

$PC \leftarrow PC + I$

T_3 : $IR \leftarrow Y$

Above μ -program is used to perform which one of the following operation.

- (a) Operand fetch
(b) Conditional jump
(c) Instruction fetch
(d) Interrupt subprogram initiation

[Ans: (c)]



Multiple Choice Questions

- Q.1 Purpose of the memory hierarchy is
(a) To reduce average memory access time
(b) To reduce memory cost per bit
(c) Both (a) and (b)
(d) None of these
- Q.2 Increasing the RAM of a computer typically improves performance because
(a) Virtual memory increases
(b) Larger RAM's are faster
(c) Fewer page faults occur
(d) Fewer segmentation faults occur
- Q.3 Consider a direct mapped cache of size 32 kB with block size 32 bytes. The CPU generates 32 bit addresses. The number of bits needed for cache indexing and the number of tag bits are respectively.
(a) 10, 17 (b) 10, 22
(c) 15, 17 (d) 5, 17
- Q.4 In a 2 level memory, if the level 1 memory is 5 times faster than level 2 and its access time is 10 ns less than avg access time. Let the level 1 memory access time is 20 ns. What is the hit ratio.
(a) 0.7 (b) 0.75
(c) 0.86 (d) 0.96
- Q.5 A hierarchical cache memory subsystem has a cache access time of 50 ns, the main storage

access time of 500 ns. With the read hit ratio of 0.9. The average access time of the system considering only memory read cycle

- (a) 10 ns (b) 100 ns
(c) 50 ns (d) 500 ns

- Q.6 In the NONIX operating system the time required for various file read operations are given below:

Disk seek time : 25 msec
Disk latency time : 8 msec
Disk transfer time : 1 msec/K byte
Operating system overhead : 1 msec/1 K byte + 10 msec

What is the time required to retrieve a block of 2 K bytes?

- (a) 45 msec (b) 47 msec
(c) 90 msec (d) 94 msec

- Q.7 Amount of time required to access L_1 cache is 4 ns having hit ratio 80% and main memory access time is 1 msec. What is average access time (in ns)?

- (a) 400002 ns (b) 200004 ns
(c) 300024 ns (d) 2000004 ns

- Q.8 Let cache of 0.7 hit having access time 9 times faster than that of memory. If average access time increase 40% from 80 ns. What would be the new hit ratio?

- (a) 0.6 (b) 0.53
(c) 0.8 (d) 0.45



Try Yourself

- T1. How many 32 K × 1 RAM chips are needed to provided a memory capacity of 256 kB?

- (a) 64 (b) 32
(c) 16 (d) 128

[GATE-2010]

- T2. How many 512 k × 8 static RAM chips are needed to design the 2 M × 32 memory module.

- (a) 32 (b) 8
(c) 16 (d) 64





Multiple Choice Questions

Q.1 A certain device dumps data into its interface register every 200 ns. The main memory access time is 50 ns. If the CPU were interfaced to this device in cycle stealing mode. What percentage of time does the CPU be in the hold state.

- (a) 20 (b) 25
(c) 50 (d) None of these

Q.2 A certain microprocessor requires 4.5 micro seconds to respond to an interrupt. Assuming that the three interrupts I_1 , I_2 and I_3 require the following execution time after the interrupt is recognized.

1. I_1 requires 25 μsec
2. I_2 requires 35 μsec
3. I_3 requires 20 μsec

I_1 has the highest priority and I_3 has the lowest. What is the possible range of time for I_3 to be executed assuming that it may or may not occur simultaneously with other interrupts.

- (a) 24.5 μsec to 39.5 μsec
(b) 24.5 μsec to 93.5 μsec
(c) 4.5 μsec to 24.5 μsec
(d) 29.5 μsec to 93.5 μsec

[ISRO-2009]

Q.3 Which one of the following is true for a CPU having single interrupt request line and a single interrupt grant line.

- (a) Neither vectored interrupt nor multiple interrupting devices are possible

- (b) Vectored interrupts are not possible but multiple interrupting devices are possible
(c) Vectored interrupts and multiple interrupting devices are both possible
(d) Vectored interrupts is possible but multiple interrupting devices are not possible

[GATE-2005]

Q.4 Consider a device of 1 MBPS is operating in a cycle stealing mode of DMA. Whenever 16 B word is available it is transferred into memory in 4 μsec . What is the % of time the processor is blocked due to DMA

- (a) 10% (b) 20%
(c) 80% (d) 90%

Q.5 A device employing INTA line for device interrupt puts the CALL instruction on the data bus while

- (a) $\overline{\text{INTA}}$ is active (b) HOLD is active
(c) Ready is active (d) None of these

[GATE-2002]

Q.6 On receiving an interrupt from an IO device, the CPU

- (a) Halts for a predetermined time
(b) Branches off to the interrupt service routine after completion of the current instruction
(c) Branches off to the interrupt service routine immediately
(d) Hands over control of address bus and data bus to the interrupting device

[ISRO-2009]

Q.7 A variable X has been assigned fresh values in statements numbered 6, 9 and 12 in a 25

statement program which does not have any jump instructions. This variable is used in statements numbered 7, 8, 10, 16 and 17. The statement ranges where the register, used by the variable X, could be assigned to some other variable are

- (a) 8-9, 10-12, 17-25
(b) 11, 18-25
(c) 17-25
(d) None of these

[DRDO-2008]

Q.8 The address bus of a computer has 16 address lines A_{15-0} . If the address assigned to one device is $7CA4_{16}$ and the address decoder for that device ignores lines A_8 and A_9 . What are all the addresses to which this device will respond.

- (a) $7CA4_{16}$, $7CA5_{16}$, $7CA6_{16}$ and $7CA7_{16}$
(b) $7C84_{16}$, $7C94_{16}$, $7CA4_{16}$ and $7CB4_{16}$
(c) $7CA4_{16}$, $7DA4_{16}$, $7EA4_{16}$ and $7FA4_{16}$
(d) $7CA4_{16}$, $6CA4_{16}$, $5CA4_{16}$ and $4CA4_{16}$

[DRDO-2009]

Q.9 With reference to the RETURN instruction. Which of the following statements is/are true?

1. The instruction can be used only to take the flow of control back to the program from which it initially jumped.
2. The instruction retrieves the address using the current stack pointer from the stack and alters the control to the program pointed to by it.
3. The instruction works only if the registers used in the main program have been pushed and later popped before its execution.
4. The instruction can be used only in conjunction with the CALL instruction.

- (a) 1 and 2 (b) 2 only
(c) 1, 2 and 4 (d) 1, 2, 3 and 4

[DRDO-2008]

Q.10 Normally user programs are prevented from handling IO directly by IO instructions in them. For CPUs having explicit IO instructions, such protection is ensured by having the IO instructions privileged. In a CPU with memory mapped IO, there is no explicit IO instructions. Which one of the following is true for a CPU with memory mapped IO.

- (a) IO protection is ensured by operating system routine
(b) IO protection is ensured by H/W trap
(c) IO protection is ensured during system configuration
(d) IO protection is not possible

[GATE-2005]

Q.11 Consider a disk pack with 16 surfaces, 128 tracks per surface and 256 sector per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively

- (a) 256 MB, 19 bits (b) 256 MB, 28 bits
(c) 512 MB, 20 bits (d) 64 GB, 28 bits

[GATE-2007]

Common Data for Questions (12 and 13):

A digital computer has memory unit with 24 bits word. The instruction set consists of 150 different operations. All instructions have an operation code part and an address part. Each instruction is stored in one word of memory.

Q.12 How many bits are needed for the OP-CODE and how many bit are left for the address of the instruction

- (a) 4, 8 (b) 8, 16
(c) 8, 64 (d) 16, 64

Q.13 What is the maximum available size for memory and the largest unsigned binary number that can be accommodated in one word of memory.

- (a) 2^{16} , $2^{24} + 1$ (b) 2^{16} , 2^{24}
(c) 2^{16} , $2^{24} - 1$ (d) None of these



Try Yourself

- T1. Assume a CPU takes 17 cycles in worst case to execute an instruction. Number of cycles required to execute current instruction by CPU is 12. If an interrupt occurs while executing current instruction, then after how many cycle it will be recognized the interrupt.
- (a) 17 (b) 11
(c) 12 (d) 17 + 2
- T2. A computer handles several interrupt sources of which the following are relevant for this question.
1. Interrupt from CPU temperature sensor (raises interrupt if CPU temperature is too high)
 2. Interrupt from mouse (raises interrupt if the mouse is moved or a button is pressed)
 3. Interrupt from keyboard (raises interrupt if when a key is pressed or released)
 4. Interrupt from hard disk (raises interrupt when a disk read is completed)

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Which one of the these will be handled at the highest priority?

- (a) Interrupt from hard disk
(b) Interrupt from mouse
(c) Interrupt from keyboard
(d) Interrupt from CPU temperature sensor

[GATE-2011]

- T3. In a vectored interrupt
- (a) The branch address is assigned to a fixed location in memory.
(b) The interrupting source supplies the branch information to the processor through an interrupt vector
(c) The branch address is obtained from a register in the processor
(d) None of these
- T4. In cycle stealing mode, the DMA gets control over _____ buses from CPU.
- (a) Data bus and Address bus
(b) Address bus and Control bus
(c) Control bus and Data bus
(d) None of these

[Ans: (a)]



4

Data Representation

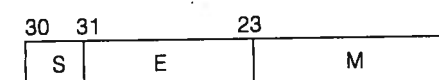


Multiple Choice Questions

- Q.1 In the IEEE floating point representations the hexadecimal value 0×00000000 corresponds to
- (a) the normalized value 2^{-127}
(b) the normalized value 2^{-126}
(c) the normalized value +0
(d) the special value +0
- Q.2 In IEEE floating point representations, all the exponent bits are 1 and mantissa bits are non-zero. This represent
- (a) 0 (b) infinity
(c) denormalized value (d) error
- Q.3 What is the result of evaluating the following two expression using three-digit floating point arithmetic with rounding
- $(113. + -111.) + 7.51$
 $113. + (-111. + 7.51)$
- (a) 9.51 and 10.0 respectively
(b) 10.0 and 9.51 respectively
(c) 9.51 and 9.51 respectively
(d) 10.0 and 10.0 respectively

Common Data for Questions (4 and 5):

Consider the following floating point format.



Bias = 31

Assume only 0 are padded while shifting a field.

- Q.4 The decimal number 0.15625×2^5 has a following hexadecimal representation without normalization
- (a) 24 28 00 00 (b) 24 10 00 00
(c) 21 28 00 00 (d) 21 10 00 00
- Q.5 The normalized representation of above number is hexadecimal format
- (a) 24 40 00 00 (b) 21 52 00 00
(c) 21 40 00 00 (d) 24 52 00 00
- Q.6 Find the decimal equivalent of the bit pattern 1 01111111 101 00000000000000000000 as per the IEEE 754 standard. In IEEE 754 a single bit precision binary floating point format is stored in 32 bits

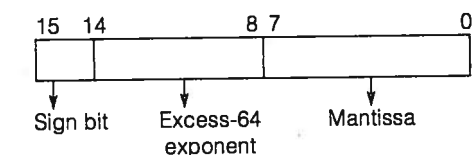
S (1 bit)	E (8 bits)	M (23 bits)
-----------	------------	-------------

Exponent is biased with 128.

- (a) 1.625 (b) -1.875
(c) -1.625 (d) .625

Common Data for Questions (7 and 8):

Consider the following floating point format



Mantissa is a pure fraction in sign magnitude form.

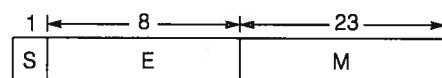
- Q.7 The decimal number 0.239×2^{13} has the following hexadecimal representation without normalization and rounding off



Try Yourself

T1. The normalized representation of for the above format is specified as follows. The mantissa has an implicit 1 preceding the binary (radix) point. Assume that only 0's are padded in while shifting a field. The normalized representation of above number is (0.239×2^{13}) is _____.

T2. Consider the following floating point format



The value of floating value number in this system is

$$V = (-1)^S \times 2^{E-127} \times 1.F$$

Find the value of the corresponding decimal value if the floating point stored is 3F800000?

■■■■

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5

Basics of Operating Systems, Networking & Programming Elements



Multiple Choice Questions

- Q.1 In physical layer data is represented in the form of
(a) Packets (b) Bits
(c) Frames (d) Segments
- Q.2 Which of the following transmission media supports 100 Mbps or higher transmission?
(a) Category 5 UTP cable
(b) Analog POTS lines
(c) RG-62 Coaxial cables
(d) High-power, single frequency radio
- Q.3 The Internet is a collection of redundant high-speed wide area links. Which network topology does the internet use?
(a) Star (b) Ring
(c) Mesh (d) Bus
- Q.4 Which OSI layer corresponds to TCP-UDP layer?
(a) Physical (b) Data link
(c) Network (d) Transport
- Q.5 At which layer, the trailer usually contains bits used for error detection?
(a) Network (b) Session
(c) Transport (d) Data link
- Q.6 Which of the following layer is responsible for the source-to-destination delivery of a packet possible across multiple networks.
(a) Network (b) Session
(c) Transport (d) Data link
- Q.7 What are the advantages of star topology
(a) Less number of cables are required

- (b) More number of cables are required
(c) It is a distributed topology
(d) Security is high

Q.8 Which of the following is not a service primitive?
(a) Connect (b) Listen
(c) Send (d) Sound

Q.9 What is the primary purpose of a VLAN?
(a) Demonstrating the proper layout for a network
(b) Simulating a network
(c) To create a virtual private network
(d) Segmenting a network inside a switch or device

[ISRO-2009]

Q.10 Which one of the following is not a client-server application?
(a) Internet chat (b) Web browsing
(c) E-mail (d) Ping

[GATE-2010]

Q.11 Why does the Data Link Layer append a trailer to frames?
(a) This is due to the router configuration.
(b) The Data Link Layer runs always in reverse mode.
(c) The Data Link Layer only appends a header, but never a trailer.
(d) This way the checksum for error correction can be done "on the fly".

Q.12 Which layer does IP belong to?
(a) Physical Layer (b) Data Link Layer
(c) Network Layer (d) Transport Layer

[Ans: (c)]

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Q.13 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- A. Session layer
- B. Transport layer
- C. Application layer
- D. MDI (Medium Dependent Interface)

List-II

- 1. Connects DCE into physical channel
- 2. Provides end to end connectivity
- 3. Provides organised means to exchange data between users
- 4. Supports an end user process and perform required file transfer

Codes:

	A	B	C	D
(a)	3	4	2	1
(b)	3	2	4	1
(c)	2	4	1	3
(d)	4	3	2	1

[Ans: (b)]

Q.14 The main objective of multiprogramming is

- (a) maximize the device utilization
- (b) minimize the response time of a job
- (c) maximize the cpu utilization
- (d) minimize the waiting time of a job.

Q.15 Which of the following is not a functionality of an operating system?

- (a) allocating the memory to program
- (b) scheduling the program under cpu
- (c) correcting the logical errors in the program
- (d) protecting the programs data not accessed by other programs

Q.16 A system with multiple cpu's called

- (a) time sharing system
- (b) desk top system
- (c) client server system
- (d) parallel system

Q.17 The primary goal of an operating system is

- (a) to make the most efficient use of the computer hardware
- (b) to allow people to use the computer
- (c) to keep systems programmers employed
- (d) to make computers easier to use.

[ISRO-2009]

Q.18 System calls are usually invoked by using

- (a) a software interrupt
- (b) polling
- (c) as indirect jump
- (d) a privileged instruction

Q.19 In memory hierarchy moving from register to hard disk, which of the following is false?

- (a) memory size increases
- (b) cost per unit decreases
- (c) access time decreases
- (d) none of the above

Q.20 RAM is

- (a) volatile memory
- (b) permanent memory
- (c) associative memory
- (d) none of the above

Q.21 Which of the following is the function of mid term scheduler in a time-sharing system?

- (a) process creation
- (b) context switching
- (c) swapping
- (d) controlling degree of multiprogramming

[JNU-2008]

Q.22 Special software to create a job queue is called as

- (a) driver
- (b) spooler
- (c) interpreter
- (d) linking editor

[ISRO-2009]

Q.23 Consider the following statements

S_1 : Throughput always increases with increase in degree of multiprogramming

S_2 : Interrupt can be handled in between the execution of an instruction.

Which of the above are true?

- (a) only s_1
- (b) only s_2
- (c) both s_1 and s_2
- (d) neither s_1 nor s_2 is true

Q.24 System calls cannot be grouped into

- (a) device management
- (b) communications
- (c) process control
- (d) none of the above

Q.25 Which of the following instructions should privileged?

- (a) set value of timer
- (b) clear memory
- (c) turn off interrupt
- (d) all of the above

Q.26 The main advantage of layered approach of OS is

- (a) modularity
- (b) genericity
- (c) debugging
- (d) abstraction

Q.27 Boot strap loader always stored in

- (a) cache
- (b) ROM
- (c) RAM
- (d) Disk

Q.28 Which of the following instructions should be allowed only in Kernel mode?

A : Disable all interrupts

B : Read the time of day clock

C : Set the time of day clock

D : Change the memory map

(a) 'A' and 'C' only (b) A, C and D only

(c) A, B and D only (d) all of them

[DRDO-2009]

Q.29 A multi user, multiprocessing O.S cannot be implemented on hardware that does not support.

- (a) Address translation
- (b) DMA for Disk transfer
- (c) At least two modes of CPU execution (privileged and non-privileged)
- (d) Demand paging.

Q.30 Which of the following statements is false?

- (a) The dual mode of operation provides a way for protecting the operating system from the errant users.
- (b) At boot time the hardware starts in privileged mode
- (c) The operating system always runs in privileged mode
- (d) None of the above.

Q.31 Which of the following is LEAST likely to be a privileged instruction?

- (a) An instruction that changes the value of a program counter.
- (b) An instruction that sends output to a printer
- (c) An instruction that modifies a memory management register
- (d) An instruction that halts the CPU.

Q.32 Distributed systems should

- (a) meet prescribed time constraints
- (b) aim better resource sharing
- (c) aim better system utilization
- (d) aim low system overhead

Q.33 The main function of shared memory is to

- (a) use primary memory efficiently
- (b) do intra process communication
- (c) do inter process communication
- (d) None of these

Q.34 Supervisor call

- (a) is a call made by the supervisor of the system
- (b) is a call with control functions
- (c) are privileged calls that are used to perform resource management functions, which are controlled by OS
- (d) is a call made by someone working in root directory

[Ans: (c)]

Q.35 Process is

- (a) A program is high level language kept on disk
- (b) Contents of main memory
- (c) A program under execution
- (d) A job in secondary memory

Q.36 Which of the following statements is false about virtual memory?

- (a) Translates programs logical address space into physical address space.
- (b) Reduce the context switching overheads.
- (c) Allows each program to exceed the size of the primary memory.
- (d) Increases degree of multiprogramming.

Try Yourself

T1. Which is not a layer in the ISO-OSI model?

- (a) Security Layer (b) Physical Layer
(c) Data Link Layer (d) Network Layer

[Ans: (a)]

T2. Choose the best matching between List-I and List-II.

List-I

- A. Data link layer
B. Network layer
C. Transport layer

List-II

1. Ensure reliable transport of data over a physical point to point link
2. Encodes/decodes data for physical transmission
3. Allow end to end communication between 2 processes
4. Routes data from one network node to the next

Codes:

- | | A | B | C |
|-----|---|---|---|
| (a) | 1 | 4 | 3 |
| (b) | 2 | 4 | 1 |
| (c) | 2 | 3 | 1 |
| (d) | 1 | 3 | 2 |

[Ans: (a)]

T3. Protocols are

- (a) Agreements on how communication components and DTE's are to communicate
(b) Logical communication channels used for transferring data

- (c) Physical communication channels used for transferring data
(d) None of the above

[Ans: (a)]

T4. Which of the following is NOT supported by the operating system?

- (a) Protection (b) Accounting
(c) Compilation (d) I/O operation

[Ans: (c)]

T5. In a multiprogramming environment

- (a) The processor executes more than one process at a time
(b) the programs are developed by the more than one person
(c) more than one process resides in the memory
(d) a single user can execute many programs at the same time

[Ans: (c)]

T6. When a computer is switched on, where is the operating system loaded?

- (a) BIOS (b) ROM
(c) POST (d) RAM

[Ans: (d)]

T7. Loading the OS into the memory of a PC is called

- (a) thrashing (b) booting
(c) formatting (d) spooling

[Ans: (b)]

■ ■ ■ ■



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