MADE EASY PUBLICATIONS

POSTAL BOOK PACKAGE 2027

ELECTRICAL ENGINEERING

OBJECTIVE PRACTICE SETS VOLUME - II

CONTENTS

CONTROL SYSTEMS

OBJECTIVE PRACTICE SETS

Page No. 2 - 113

1 CHAPTER Introduction

Q.1 A control system is represented by $y(t) = x(t + T)$ with $T > 0$. Is the system causal?
(a) Yes (b) No
(c) Not necessarily (d) None of these

Q.2 $s(t)$ is step response and $h(t)$ is impulse response of a system. Its response $y(t)$ for any input $u(t)$ is given by

(a) $\frac{d}{dt}\int_0^t s(t-\tau)\,u(\tau)\,d\tau$

(b) $\int_0^t s(t-\tau)\,u(\tau)\,d\tau$

(c) $\int_0^t \int_0^t s(t-\tau_1)\,u(\tau_1)d\tau_1\,d\tau$

(d) $\int_0^t h(t-\tau)u(\tau)d\tau$

Q.3 Consider the following statements:
Statement 1: The difference between the output response and the reference signal is called actuating signal.
Statement 2: If the initial conditions for a system are inherently zero, it means system is at rest or no energy stored in any of its parts.
(a) Statement 1 is wrong, 2 is correct
(b) Statement 1 is correct, 2 is wrong
(c) Both the statement are correct
(d) Both the statements are wrong

Q.4 A certain LTI system has input $r(t)$ and output $c(t)$. If the input is first passed through a block whose T.F. is e^{-s} and then applied to system. The modified output will be
(a) $c(t)\,u(t-1)$ (b) $c(t-1)\,u(t)$
(c) $c(t-1)\,u(t-1)$ (d) none of these

Q.5 For the given transfer function what will be the initial value $F(s) = \frac{(2s+1)}{s(4s+3)}$?
(a) $\frac{1}{3}$ (b) $\frac{1}{2}$
(c) $\frac{2}{3}$ (d) 0

Q.6 The compensator $G(s) = \frac{16(1+30s)}{(1+5s)}$ would provide gain at high frequency,
(a) 24.08 dB (b) 55.45 dB
(c) 91.28 dB (d) 39.65 dB

Q.7 The final value of the function $F(s) = \frac{5}{s(s^2+s+2)}$ is equal to ________.

Q.8 The voltage across an element in a circuit is given by $V(s) = \frac{1}{s(s+\alpha)}$. If $v(\infty)$ is equal to 4 V then the value of $v(t)$ at t = 1 sec is ____________ V.

Q.9 **Assertion (A):** A linear system gives a bounded output if the input is bounded.
Reason (R): The roots of the characteristic equation have all negative real parts and response due to initial conditions decay to zero as time t tends to infinity.
(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

■■■■

Answers Introduction

1. (b) 2. (d) 3. (d) 4. (c) 5. (b) 6. (d) 7. (2.5) 8. (0.885) 9. (d)

Explanations Introduction

1. (b)

$$y(t) = x(t+T)$$

Taking Laplace transform,

$$Y(s) = X(s)e^{sT}$$

$$H(s) = \frac{Y(s)}{X(s)} = e^{sT}$$

Taking inverse Laplace transform

$$h(t) = \delta(t+T),\ T > 0$$

Thus, $h(t) \neq 0$, $t < 0$, its an impulse at $t = -T$.

System is causal if $h(t) = 0$, $t < 0$.

2. (d)

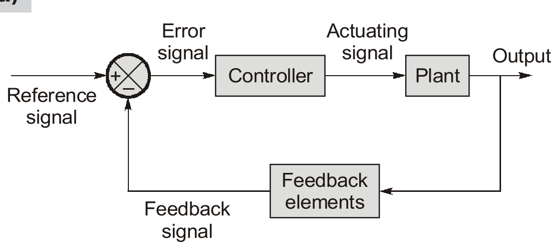
$$y(t) = x(t) \otimes h(t)$$

$$y(t) = u(t) \otimes h(t)$$

$$y(t) = \int_{-\infty}^{\infty} h(t-\tau)\,u(\tau)dt$$

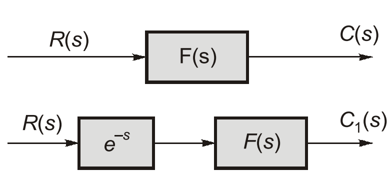
$$y(t) = \int_{0}^{t} h(t-\tau)\,u(\tau)d\tau$$

3. (d)



Error signal = Reference – Output

4. (c)



$$C(s) = F(s)\,R(s)$$

$$C_1(s) = R(s)\cdot e^{-s}\cdot F(s)$$

$$C_1(s) = C(s)\,e^{-s}$$

$$\because \quad L^{-1}[F(s)\,e^{-as}] = f(t-a)\,u(t-a)$$

$$\therefore \quad c_1(t) = c(t-1)\,u(t-1)$$

5. (b)

By initial value theorem $\lim_{t\to 0} f(t) = \lim_{s\to\infty} sF(s)$

where $F(s)$ is Laplace transform of $f(t)$.

So, Initial value $= \lim_{s\to\infty} \frac{s(2s+1)}{s(4s+3)}$

$$= \lim_{s\to\infty} \frac{2\left(1+\frac{1}{s}\right)}{4\left(1+\frac{3}{4s}\right)} = \frac{2}{4}\frac{(1+0)}{(1+0)}$$

$$= \frac{1}{2}$$

6. (d)

Sinusoidal transfer function is given by

$$G(j\omega) = \frac{16(1+j30\omega)}{(1+j5\omega)}$$

Solving, we get

$$G(j\omega) = \frac{16\times j\omega\left(\frac{1}{j\omega}+30\right)}{j\omega\left(\frac{1}{j\omega}+5\right)}$$

At $\omega \to \infty$ (high frequency)

$$G(j\omega)_{\omega\to\infty} = \frac{16\times\left(\frac{1}{\infty}+30\right)}{\left(\frac{1}{\infty}+5\right)} = 96$$

Gain in dB = 20 log 96

gain = 39.65 dB

7. (2.5)

$$F(s) = \frac{5}{s(s^2+s+2)}$$

$$\text{Final value} = \lim_{s\to 0} s\,F(s)$$

$$= \lim_{s\to 0} \frac{5s}{s(s^2+s+2)} = \frac{5}{2}$$

8. (0.885)

$$V(s) = \frac{1}{s(s+\alpha)}$$

By $v(\infty) = \lim_{t\to\infty} v(t) = \lim_{s\to 0} sV(s)$

By final value theorem

$$v(\infty) = \frac{1}{\alpha} = 4 \quad \Rightarrow \quad \alpha = \frac{1}{4}$$

Now, $$V(s) = \frac{1}{s(s+\alpha)}$$

By partial fraction

$$V(s) = \frac{1}{\alpha}\left[\frac{1}{s} - \frac{1}{s+\alpha}\right]$$

$$V(s) = 4\left[\frac{1}{s} - \frac{1}{s+\alpha}\right]$$

By inverse Laplace transform

$$v(t) = 4[1 - e^{-\alpha t}] = 4[1 - e^{-t/4}]$$

$$v(t = 1\text{ sec}) = 4[1 - e^{-1/4}] = 0.885\text{ V}$$

9. (d)

Assertion is wrong as it is applicable only for the BIBO (Bounded Input Bounded Output) stable system.

Moreover if the system is unbounded then assertion will be wrong.

■■■■

ANALOG ELECTRONICS

OBJECTIVE PRACTICE SETS

Page No. 114 - 193

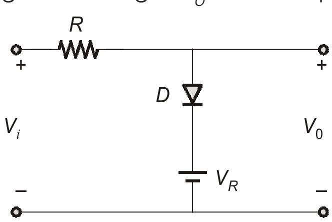
1 CHAPTER Basics of Semiconductor Diodes

MCQ and NAT Questions

Q.1 A diode whose terminal characteristics are related as $i_D = I_s e^{V/V_T}$, where I_s is the reverse saturation current and V_T is thermal voltage (V_T = 25 mV), is biased at I_D = 4 mA. Its dynamic resistance is

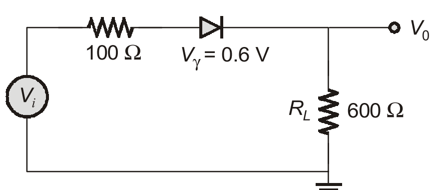
(a) 12.5 Ω (b) 50 Ω
(c) 6.25 Ω (d) 25 Ω

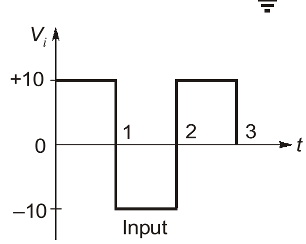
Q.2 In the circuit shown below the input V_i has positive and negative swings. V_o is the output.



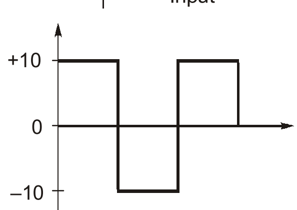
(a) V_o = 0 for negative V_i
(b) $V_o = V_R$ for positive V_i
(c) $V_o = V_R$ for $V_i > V_R$
(d) $V_o = V_R$ for all V_i

Q.3 In the circuit shown below, if the input voltage V_i is as shown below then the corresponding output waveform will be

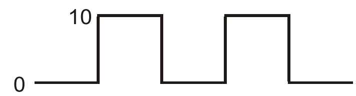




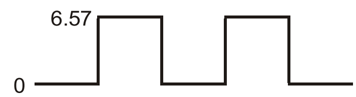
(a)



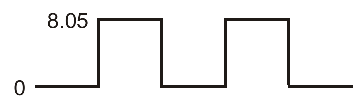
(b)



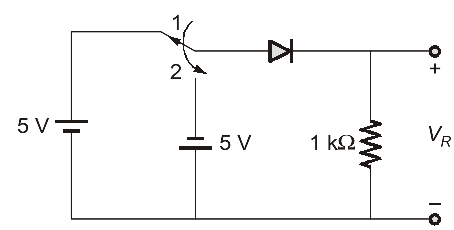
(c)



(d)

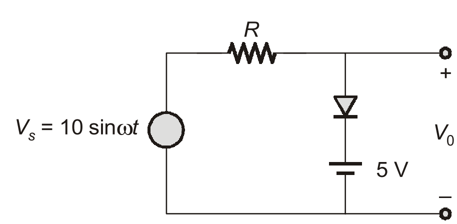


Q.4 In the circuit shown below, the switch was connected to position 1 at $t < 0$ and at $t = 0$, it is changed to position 2. Assume that the diode has zero voltage drop and a storage time t_s. For $0 < t \leq t_s$, V_R is given by (all in Volts)

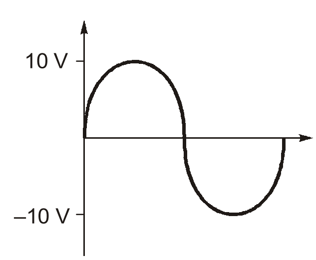


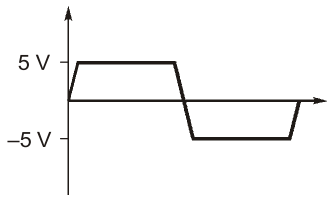
(a) $V_R = -5$ (b) $V_R = 0$
(c) $0 \leq V_R < 5$ (d) $-5 < V_R < 0$

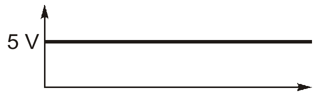
Q.5 For the circuit shown below assuming ideal diode, the output waveform V_0 is

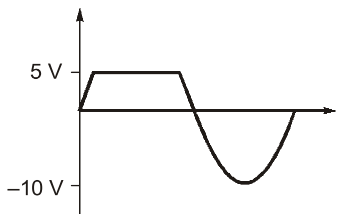


(a)

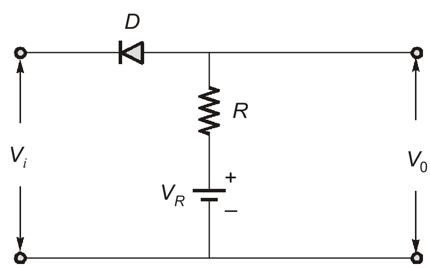


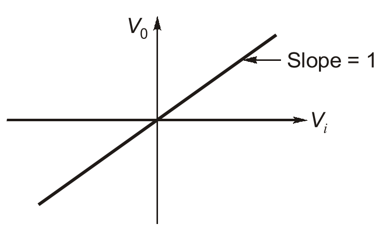
(b)


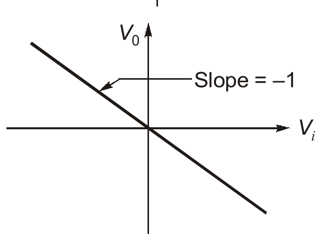
(c)


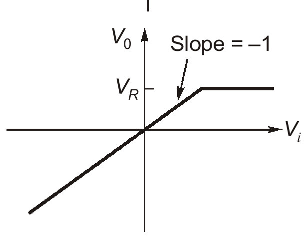
(d)


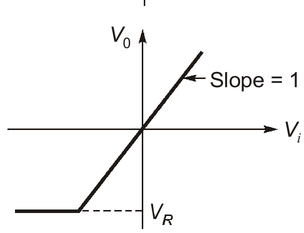
Q.6 The transfer characteristic of the network shown below is represented as



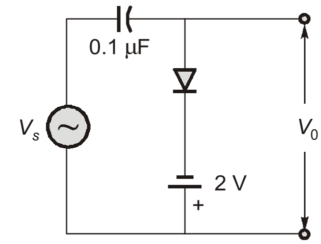
(a)


(b)


(c)


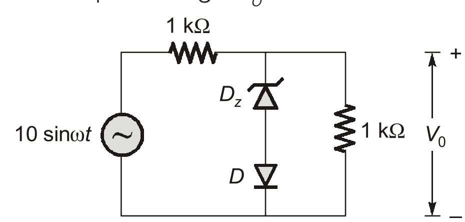
(d)


Q.7 For an input of V_s = 5 sinωt, (assuming ideal diode), circuit shown below will behave as a



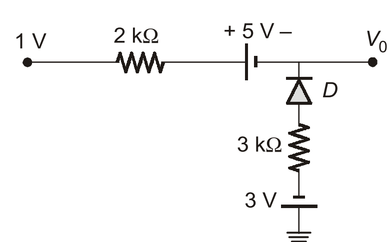
(a) clipper, sine wave clipped at –2 V
(b) clamper, sine wave clamped at –2 V
(c) clamper, sine wave clamped at zero volt
(d) clipper, sine wave clipped at 2 V

Q.8 The cut-in voltage of diode D shown in figure is 0.65 V, while breakdown voltage of the zener diode is 3 V. Diode is considered to be ideal. The value of peak output voltage V_o.



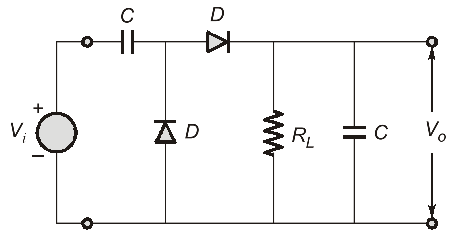
(a) 3 V in the positive half cycle and 0.65 V in the negative half cycle.
(b) 3.65 V in the positive half cycle and –5 V in the negative half cycle.
(c) 3 V in positive half cycle and –5 V in the negative half cycle
(d) –3.65 V in positive half cycle and 5 V in the negative half cycle

Q.9 What is the output voltage V_0 for the circuit shown below assuming an ideal diode?



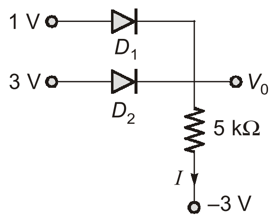
(a) $-\frac{18}{5}$ V (b) $\frac{18}{5}$ V
(c) $-\frac{13}{5}$ V (d) $\frac{13}{5}$ V

Q.10 Consider the below circuit, for $V_i = V_m \sin \omega t$, the output voltage V_o for $R_L \to \infty$ will be



(a) Zero (b) V_m
(c) $2\,V_m$ (d) $-V_m$

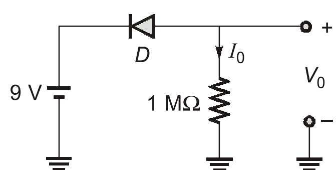
Q.11 Consider the circuit shown in the figure below:



If diode D_1 and D_2 are made up of same material with the cut-in voltage $V_\gamma = 0.7$ V, then the value of current I is equal to

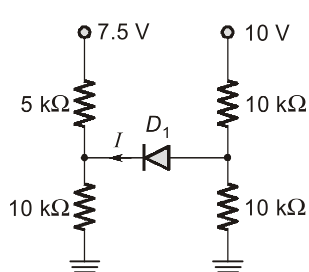
(a) 0.46 mA (b) 0.99 mA
(c) 0.59 mA (d) 1.06 mA

Q.12 Consider the diode circuit shown in the figure below:



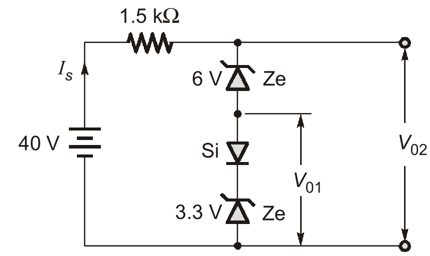
The diode in the circuit is a large high-current silicon device whose reverse leakage current is reasonably independent of voltage appearing on the diode. If $V_0 = 1$ V at 20° C, then the value of output voltage at 40°C is equal to ______ V.

Q.13 Consider the circuit shown in the figure below



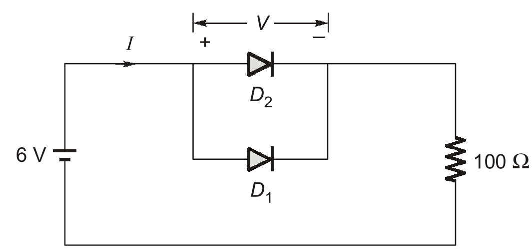
If the cut-in voltage of the diode D_1 is equal to 0.7 V, then the value of current flowing through the diode is equal to ________ mA.

Q.14 A 40 V dc supply is connected across the network comprising of Zener and Silicon diodes as shown. The regulated voltages V_{01}, V_{02} and source current I_s are



(a) 2.4 V, 5.1 V and 21.7 mA
(b) 3 V, 6 V and 22.7 mA
(c) 3.3 V, 9.3 V and 20.5 mA
(d) 4 V, 10 V and 20 mA

Q.15 In the given circuit, D_1 is an ideal germanium diode and D_2 is a silicon diode having its cut-in voltage as 0.7 V, forward resistance as 20 Ω and reverse saturation current (I_s) as 10 nA. What are the values of I and V for this circuit, respectively?



(a) 60 mA and 0 V (b) 50 mA and 0 V
(c) 53 mA and 0.7 V (d) 44 mA and 1.58 V

Q.16 Consider the following statements :
A clamper circuit
1. adds/subtracts a dc voltage to/from a waveform.
2. does not change the shape of the waveform.
3. amplifies the waveform.

Of these statements
(a) 1 and 2 are correct
(b) 1 and 3 are correct
(c) 2 and 3 are correct
(d) 1, 2 and 3 are correct

Q.17 In order to rectify sinusoidal signals of millivolt range (< 0.6 V)
(a) bridge rectifier using diodes can be employed
(b) full-wave diode rectifier can be used
(c) a diode is to be inserted in the feedback loop of an OP-AMP
(d) a diode is to be inserted in the input of an OP-AMP

Answers — Basics of Semiconductor Diodes

1. (c)	2. (c)	3. (d)	4. (a)	5. (d)	6. (c)	7. (b)	8. (b)
9. (a)	10. (c)	11. (d)	12. (4)	13. (0)	14. (d)	15. (a)	16. (a)
17. (c)	18. (c)	19. (a)	20. (c)	21. (d)	22. (c)	23. (b)	24. (b)
25. (a)	26. (d)	27. (c)	28. (a)	29. (c)	30. (c)	31. (d)	32. (d)
33. (b)	34. (b)	35. (d)	36. (c)	37. (a)	38. (b)	39. (a)	40. (c)
41. (d)	42. (b)	43. (d)	44. (b)	45. (d)	46. (b)	47. (a)	48. (d)
49. (b)	50. (d)	51. (b)	52. (c)	53. (d)	54. (b)	55. (a)	56. (a)
57. (b)	58. (d)	59. (b)	60. (b)	61. (c)	62. (c)	63. (c)	64. (500)
65. (1.048)	66. (b)	67. (d)	68. (b)	69. (b)	70. (c)	71. (d)	72. (b)
73. (a)	74. (c)	75. (b)	76. (b)	77. (d)	78. (d)	79. (a)	80. (d)
81. (b)	82. (b)	83. (c)	84. (d)	85. (c)	86. (c)	87. (b)	88. (a)
89. (b)	90. (d)	91. (c)	92. (d)	93. (b)	94. (c)	95. (b)	96. (c)
97. (a)	98. (b)	99. (c)	100. (a)	101. (b)	102. (a)	103. (a)	104. (c)
105. (0.12)	106. (40)	107. (10)	108. (b)	109. (c,d)	110. (a,b,c,d)	111. (a,b,c,d)	112. (a,d)

Explanations — Basics of Semiconductor Diodes

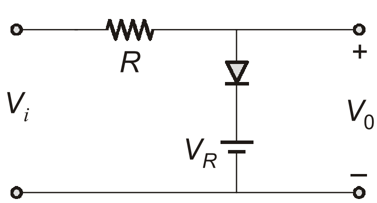
1. (c)

$$\frac{1}{r_d} = \frac{\partial I_D}{\partial V} = \frac{I_D}{V_T}$$

r_d : dynamic resistance.

$$\therefore \quad r_d = \frac{V_T}{I_D} = \frac{25}{4} = 6.25\ \Omega$$

2. (c)



Considering ideal diode :

for $V_i < V_R$, diode is OFF hence there is no current through R and $V_0 = V_i$.

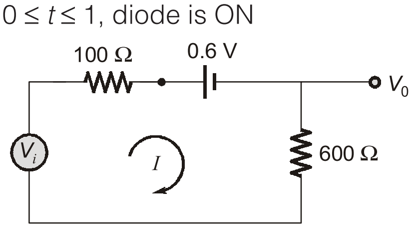
For $V_i > V_R$, diode is ON hence

$$V_0 = V_R$$

(as diode will act as short circuit)

3. (d)

For $0 \le t \le 1$, diode is ON



$$I = \frac{V_i - 0.6}{100 + 600} = \frac{10 - 0.6}{700}$$

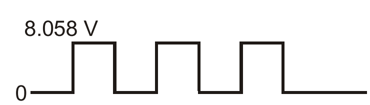
$$= 0.01343\ \text{A}$$

$$\therefore \quad V_0 = 600 \times 0.01343 = 8.058\ \text{V}$$

For $1 < t < 2$, diode is OFF, there will be no current in the circuit and hence

$$V_0 = 0\ \text{V}$$

Hence output waveform can be given as shown below:



4. (a)

For $0 < t < t_s$ diode will remain ON and hence

$$V_R + 5 = 0$$

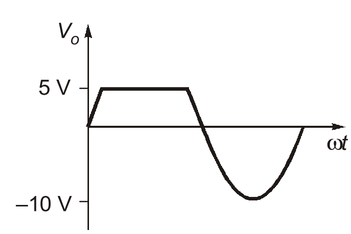
$$\therefore \quad V_R = -5\ \text{V}$$

5. (d)

For $0 \le V_i < V_R$ = diode is OFF $\Rightarrow V_0 = V_i$

For $V_R \le V_i \Rightarrow$ diode is ON $\Rightarrow V_0 = 5$ V

Hence output waveform can be as shown below

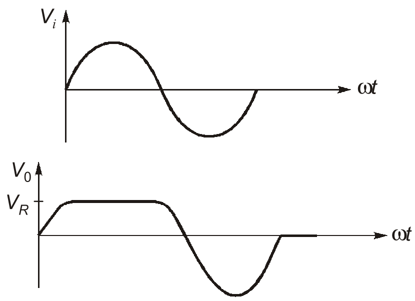


6. (c)

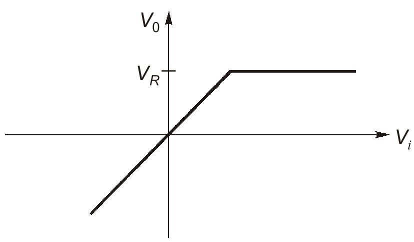
For $V_i < V_R$ = Diode is OFF $\Rightarrow V_0 = V_i$

For $V_i > V_R$ = Diode is ON $\Rightarrow V_0 \simeq V_R$

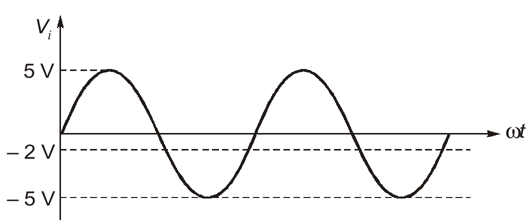
Hence for a sinusoidal input, output can be shown as below



Hence characteristic can be as shown below



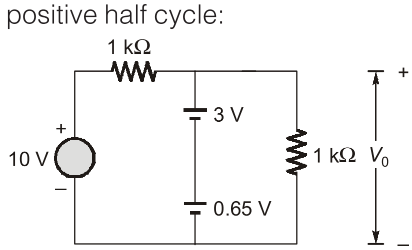
7. (b)



Hence given circuit acts as a clamper, sine wave clamped at – 2 V.

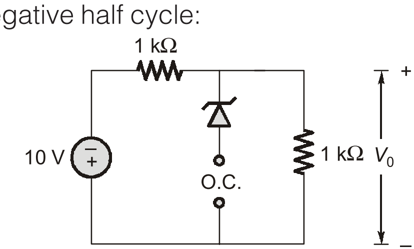
8. (b)

For positive half cycle:



So, $V_o = 3.65$ V

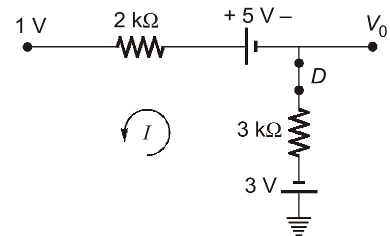
In negative half cycle:



So, $V_o = -5$ V

9. (a)

∵ Diode is forward bias (short circuit)



By applying KVL,

$3\text{ V} + 3\text{ k}\Omega I - 5\text{ V} + 2\text{ k}\Omega I + 1\text{ V} = 0$

$$I = \frac{1\text{V}}{5\text{k}\Omega} = \frac{1}{5}\text{ mA}$$

$$\therefore \quad V_o = -3 - 3\times\frac{1}{5} = -\frac{18}{5}\text{ V}$$

10. (c)

The given circuit is a voltage doubler. Hence,

$$V_o = 2\,V_m$$

11. (d)

When D_2 is ON then the value of V_0 will be

$$V_0 = 3 - 0.7\text{ V} = 2.3\text{ V}$$

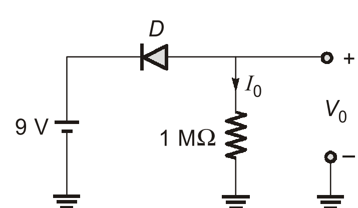
Hence, D_1 will be OFF.

Thus, The current,

$$I = \frac{2.3-(-3)}{5}\times 10^{-3}$$

$$= \frac{5.3}{5}\times 10^{-3} = 1.06\text{ mA}$$

12. (4)



Calculating the value of reverse saturation current (I_{01}) flowing through the diode at 20°C

We get,

$$I_{01} = \frac{V_0}{1\text{M}\Omega} = 1\mu\text{A} \quad (\text{for } V_0 = 1\text{ V})$$

The reverse saturation current doubles for every 10° rise in temperature. Hence, the rise in temperature.

$$\Delta T = (40° - 20°)\text{C} = 20°\text{ C}$$

Thus, $$I_{02} = I_{01}2^{(\Delta T/10)}$$

DIGITAL ELECTRONICS

OBJECTIVE PRACTICE SETS

Page No. 194 - 277

1 CHAPTER Number Systems and Codes

MCQ and NAT Questions

Q.1 "BAD" is the hexadecimal representation of a binary number. If the number represents only the magnitude, its decimal equivalent is

(a) 2749 (b) 2989
(c) 1213 (d) 111013

Q.2 Which of the following is a self-complementary code?

(a) 8421 code (b) Excess 3 code
(c) Pure binary code (d) Gray code

Q.3 A Gray code is a/an:

(a) Binary weight code
(b) Arithmetic code
(c) Code which exhibits a single bit change between two successive codes
(d) Alphanumeric code

Q.4 If $(211)_x = (152)_8$, then the value of base 'x' is

(a) 3 (b) 5
(c) 7 (d) 9

Q.5 The decimal number 4097 is represented in four forms as shown below. Match **List-I (Type of Representation)** with **List-II (Number)** and select the correct answer:

	List I		List II
A.	Binary	**1.**	0000 0000 0000 1001
B.	BCD	**2.**	0000 0000 0001 0001
C.	Octal	**3.**	0001 0000 0000 0001
D.	Hexadecimal	**4.**	0100 0000 1001 0111

Codes:

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

Q.6 The range of numbers that can be represented in two's complement mode with four binary digits is

(a) – 15 to +15 (b) – 8 to +8
(c) – 8 to +7 (d) – 7 to +7

Q.7 $(24)_8$ is expressed in Gray code as which one of the following?

(a) 11000 (b) 10100
(c) 11110 (d) 11111

Q.8 The 2's complement representation of –17 is

(a) 101110 (b) 101111
(c) 111110 (d) 110001

Q.9 A number is expressed as 1023 with radix x. Given that the number uses all the symbols of the number system, which of the following is correct?

(a) x = 3 and its decimal value is 37
(b) x = 2 and its decimal value is 14
(c) x = 4 and its decimal value is 15
(d) x = 4 and its decimal value is 75

Q.10 **Statement 1:** The range of unsigned decimal values that can be represented (using binary system) in a byte is 256.

Statement 2: The range of signed decimal values that can be represented (by signed binary using 2's complement) in a byte is 256.

(a) Statement 1 is TRUE
(b) Statement 2 is TRUE
(c) Statement 1 and Statement 2 both are TRUE
(d) Both are FALSE

Q.11 **Statement 1:** 256 different signed decimal values can be represented in a byte.

Statement 2: In 2's complement system.

$1\,1\,1\,1\,0\,1\,0\,0_2 = -12_{10}$

(a) statement 1 is TRUE
(b) statement 2 is TRUE
(c) both statements are TRUE
(d) both statements are FALSE

Q.12 For the given Grey code 10110 what will be the binary equivalent code?

(a) 10110 (b) 11101
(c) 11011 (d) None of these

Q.13 Which of the following represents seven bit code?
1. ASCII
2. BCD
3. EBCDIC
4. Selectric

Select the correct answer using the codes given below :
(a) 1 and 4 (b) 1 and 2
(c) 1 and 3 (d) 2 and 3

Q.14 With 2's complement representation, the range of values that can be represented on the data bus of an 8 bit microprocessor is given by
(a) –128 to +127 (b) –128 to +128
(c) –127 to +128 (d) –256 to +256

Q.15 The binary number 00001011 when represented in BCD format, is given by
(a) 00001011 (b) 10111011
(c) 00010001 (d) 10001000

Q.16 Hamming codes are used for error detection and correction. If the minimum Hamming distance is m, then the number of errors correctable is
(a) equal to m (b) less than m/2
(c) equal to 2 m (d) greater than m

Q.17 In signed magnitude representation, the binary equivalent of 22.5625 is (the bit before comma represents the sign)
(a) 0, 10110.1011 (b) 0, 10110.1001
(c) 1, 10101.1001 (d) 1, 10110.1001

Q.18 **Assertion (A):** A 16-bit data contained in a certain location of a computer memory can be expressed in terms of four hexadecimal digits only.

Reason (R): The hexadecimal number system has a base that is four times the base of binary number system.

(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 a correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Q.19 What will be the excess-3 code representation of the number $(64)_{10}$?
(a) 01000011 (b) 01110011
(c) 01000000 (d) 10010111

Q.20 The addition of two number $(-64)_{10}$ and $(80)_{16}$ is
(a) $(-16)_{10}$ (b) $(16)_{10}$
(c) $(1100000)_2$ (d) $(01000000)_2$

Q.21 Given that the largest *n*-bit binary number requires d digits in decimal representation. Which one of the following relations between n and d is approximately correct?
(a) $d = 2^n$ (b) $n = 2^d$
(c) $d < n \log_{10}2$ (d) $d > n \log_{10}2$

Q.22 A signed integer has been stored in a byte using the 2's complement format. We wish to store the same integer in a 16 bit word. We should
(a) copy the original byte to the less significant byte of the word and fill the more significant byte with zeros.
(b) copy the original byte to the more significant byte of the word and fill the less significant byte with zeros.
(c) copy the original byte to the less significant byte of the word and make each bit of the more significant byte equal to the most significant bit of the original byte.
(d) copy the original byte to the less significant bytes well as the more significant byte of the word.

Q.23 Consider the following operation

$$(23)_x + (21)_x = (y)_x$$

What is the minimum value of '*y*' that is possible?
(a) $(17)_{10}$ (b) $(20)_{10}$
(c) $(44)_{10}$ (d) $(110)_{10}$

Q.24 Consider the following statements:
1. When two unsigned numbers are added, an overflow is detected from the carry into the most significant position.
2. An overflow does not occur if the two numbers added are both negative.
3. If the carry into the sign bit position and carry out of the sign bit position are not equal, an overflow condition is produced.

Which of the above statement(s) is/are correct?
(a) 1, 2 and 3 (b) 1 only
(c) 2 only (d) 3 only

Q.25 2's complement representation of a 16-bit signed number is FFFFH. Its magnitude in decimal representation is
(a) 0 (b) 1
(c) 32767 (d) 65535

Answers Number Systems and Codes

1. (b)	2. (b)	3. (c)	4. (c)	5. (c)	6. (c)	7. (c)
8. (b)	9. (d)	10. (c)	11. (c)	12. (c)	13. (a)	14. (a)
15. (c)	16. (b)	17. (b)	18. (c)	19. (d)	20. (d)	21. (d)
22. (c)	23. (b)	24. (d)	25. (b)	26. (4)	27. (–8)	28. (2)
29. (8)	30. (4)	31. (15)	32. (b, c)	33. (c, d)	34. (a, b, c)	35. (b, c, d)
36. (b, d)	37. (b, c, d)	38. (c, d)				

Explanations Number Systems and Codes

1. (b)

$$(BAD)_{16} = B \times 16^2 + A \times 16^1 + D \times 16^0$$
$$= 11 \times 256 + 10 \times 16 + 13$$
$$= (2989)_{10}$$

2. (b)

Self complementing code:
Excess – 3 code, 2421, 3221, 4311, 5211
It is one that 9's complement in decimal is the 1's complement in binary.

3. (c)

A Gray code is a code which exhibits a single bit change between two successive codes.

4. (c)

$$(211)_x = (152)_8$$

Converting to decimal

$$2x^2 + x + 1 = 8^2 \times 1 + 8 \times 5 + 2 = 106$$

on solving, $x = 7, -15/2$

5. (c)

Binary: 0001 0000 0000 0001

$$2^{12} + 2^0 = 4097$$

BCD: 0100 0000 1001 0111
↓ 4 ↓ 0 ↓ 9 ↓ 7

Octal: 0000 0000 0001 0001

$\rightarrow 1 \times 8^4 + 1 \times 8^0$

$\rightarrow 4097$

Hexadecimal: 0000 0000 0000 1001

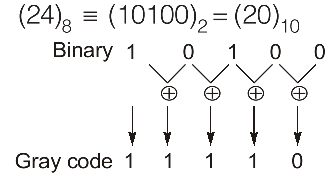
$$= 1 \times 16^3 + 1 \times 16^0$$
$$= 4097$$

6. (c)

Range of signed magnitude and 1's complement representation for n-bit is $= -(2^{n-1} - 1)$ to $(2^{n-1} - 1)$
for 2's complement : -2^{n-1} to $(2^{n-1} - 1)$

7. (c)

$$(24)_8 \equiv (10100)_2 = (20)_{10}$$



8. (b)

2's complement of a number = 1's complement + 1

$$(17)_{10} = 010001$$

1's complement of $(17)_{10}$ = 1 0 1 1 1 0
\+ 1
2's complement 1 0 1 1 1 1

9. (d)

Given $(1023)_x$
We know that radix x is always greater than any number inside it.
Hence, $x \geq 4$
Now by options check $x = 4$
So, $(1023)_4 = 1 \times 4^3 + 0 \times 4^2 + 2 \times 4^1 + 3 \times 4^0$
$= 64 + 0 + 8 + 3 = (75)_{10}$

10. (c)

In unsigned, range with n bit is 0 to $2^n - 1$
Here, 1 byte = 8 bit
∴ $0 \rightarrow 2^8 - 1$
$= 0 - 255$
for 2's complement $-(2^{n-1})$ to $(2^{n-1} - 1)$

11. (c)

2's complement of $(11110100)_2$

$$= 00001011$$
$$\quad\quad 1$$
$$\text{-----------}$$
$$00001100 = 12$$
$$\text{-----------}$$

But in 2's complement representation, MSB is '1' i.e. number is negative.

12. (c)

Given Gray code 1 0 1 1 0

Binary code will be 1 1 0 1 1

13. (a)

Seven bit code : ASCII, selectric

EBCDIC : 8-bit code

BCD : 4-bit code

14. (a)

For 8-bit 2's complement : – 128 to 127

15. (c)

Convert binary into decimal

$00001011 \rightarrow 2^3 \cdot 1 + 2^1 \cdot 1 + 2^0 \cdot 1 = 11$

$(11)_{10} = (0\,0\,0\,1 \quad 0\,0\,0\,1)_2$

16. (b)

No. of errors correctable in hamming code for m hamming distance < $m/2$.

17. (b)

$\because$ + 22.5625

$+ \rightarrow 0$

$- \rightarrow 1$

2	22	
2	11	0
2	5	1
2	2	1
	1	0

$\therefore \quad 22 = (10110)_2$

$0.5625 \times 2 = 1.1250 \rightarrow 1$

$0.1250 \times 2 = 0.2500 \rightarrow 0$

$0.2500 \times 2 = 0.5 \rightarrow 0$

$0.5 \times 2 = 1 \rightarrow 1$

$\therefore (1001)_2$

$\therefore \quad (22.5625) = (10110.1001)_2$

18. (c)

Hexadecimal, decimal, binary number system has a base 16, 10, 2 respectively.

19. (d)

Given, $(64)_{10} = (01000000)_2$

To convert into excess 3, first convert into BCD code.

$(64)_{10} \xrightarrow{BCD} \overset{6}{0110}\ \overset{4}{0100}$

Now add $(3)_{10}$ = 0011 into each Nibble.

So, $(64)_{10} \xrightarrow{\text{Excess 3}}$

$$\begin{array}{r} 0110\ 0100 \\ +\ 0011\ 0011 \\ \hline 1001\ 0111 \end{array}$$

20. (d)

$$(80)_{16} = (128)_{10}$$
$$(128)_{10} + (-64)_{10} = (64)_{10}$$
$$(64)_{10} = (01000\,000)_2$$

21. (d)

For n-bit number

$$d > n \log_{10} 2$$

For $n = 1, 2, 3 \quad d = 1$

For $n = 4, 5, 6 \quad d = 2$

For $n = 7, 8, 9 \quad d = 3$

For $n = 10, 11, 12, 13 \quad d = 4$

For any n, $d > n \log_{10} 2$ is correct.

22. (c)

The MSB of the integer in 8 bit format should be repeated to expand the representation of 2's complement form to 16 bit.

23. (b)

For minimum value of 'y' the value of 'x' should be minimum

$\therefore$ minimum value of $x = 4$

$\therefore (23)_4 + (21)_4 = (110)_4 = (4^2 + 4 + 0)_{10} = (20)_{10}$

24. (d)

1. When two unsigned numbers are added, an overflow is detected from the carry out of most significant bit. (not into most significant bit)
2. Overflow does not occur if the numbers are of opposite sign otherwise it may occur.
3. In signed operation, if carry into sign bit and carryout of the sign bit are not equal, overflow occurs else overflow does not occur.

SIGNALS AND SYSTEMS

OBJECTIVE PRACTICE SETS

Page No. 278 - 339

1
CHAPTER

Basics of Signals and Systems

MCQ and NAT Questions

Q.1 If a function $f(t)\ u(t)$ is shifted to right side by t_0, then the function can be expressed as
(a) $f(t - t_0)\ u(t)$
(b) $f(t)\ u(t - t_0)$
(c) $f(t - t_0)\ u(t - t_0)$
(d) $f(t + t_0)\ u(t + t_0)$

Q.2 If $a(n)$ is the response of a linear, time-invariant, discrete-time system to a unit step input, then the response of the same system to a unit impulse input is
(a) $\frac{d}{dn}[a(n)]$
(b) $na(n)$
(c) $a(n) - a(n - 1)$
(d) $a(n + 1) - 2a(n) + a(n - 1)$

Q.3 The unit impulse response of a linear time invariant system is the unit step function $u(t)$. For $t > 0$, the response of the system to an excitation $e^{-at}\,u(t)$, $a > 0$ will be
(a) ae^{-at} (b) $(1/a)(1 - e^{-at})$
(c) $a(1 - e^{-at})$ (d) $1 - e^{-at}$

Q.4 The unit step response of a system is given by $(1 - e^{-at})\ u(t)$, the impulse response is given by
(a) $e^{\alpha t}\,u(t)$ (b) $e^{-\alpha t}\,u(t)$
(c) $\frac{1}{\alpha}e^{-\alpha t}u(t)$ (d) $\alpha e^{-\alpha t}\,u(t)$

Q.5 A function $f(t)$ is an even function, if for all values of t
(a) $f(t) = f(-t)$ (b) $f(t) = -f(-t)$
(c) $f(t) = f(t + T/2)$ (d) $f(t) = -f(t + T/2)$
(T is the time-period of the function)

Q.6 The function $\delta(2n)$ is equal to
(a) $\delta(n)$ (b) $\frac{1}{2}\delta(n)$
(c) $2\delta(n)$ (d) $2\delta\left(\frac{n}{2}\right)$

Q.7 If $x_1(t) = 2\sin \pi t + \cos 4\pi t$ and $x_2(t) = \sin 5\pi t + 3\sin 13\pi t$, then
(a) $x_1(t)$ and $x_2(t)$ both are periodic.
(b) $x_1(t)$ and $x_2(t)$ both are not periodic.
(c) $x_1(t)$ is periodic, but $x_2(t)$ is not periodic.
(d) $x_1(t)$ is not periodic, but $x_2(t)$ is periodic.

Q.8 Energy signals are the signals with
(a) $0 < E < \infty,\ P = 0$ (b) $0 < E < \infty,\ P = \infty$
(c) $0 < P < \infty,\ E = \infty$ (d) $0 < P < \infty,\ E = 0$

Q.9 Power signals are the signals with
(a) $0 < E < \infty,\ P = 0$
(b) $0 < E < \infty,\ P = \infty$
(c) $0 < P < \infty,\ E = \infty$
(d) $0 < P < \infty,\ E = 0$

Q.10 A signum function is
(a) zero for t greater than zero
(b) zero of t less than zero
(c) unity for t less than zero
(d) $2\,u(t) - 1$

Q.11 The average value of the waveform $x(t) = 4\cos 4t - 5\sin 5t$ is
(a) 0 (b) $-\left(\frac{2}{\pi}\right)$
(c) $\frac{2}{\pi}$ (d) $\frac{20}{\pi}$

Q.12 If two signals are given as,

$$x_1(t) = e^{jt} \text{ and } x_2(t) = e^{t(j+1)}$$

Then which one of the following statements is correct?
(a) Both $x_1(t)$ and $x_2(t)$ are periodic
(b) Only $x_1(t)$ is periodic
(c) Only $x_2(t)$ is periodic
(d) Neither $x_1(t)$ nor $x_2(t)$ is periodic

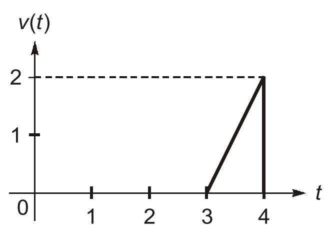
Q.13 If a continuous time signal $x(t)$ can take on any value in the continuous interval $(-\infty, \infty)$, it is called
(a) Deterministic signal (b) Random signal
(c) Analog signal (d) Digital signal

Q.14 Which of the following statements is/are true?

1. If $x(t)$ is a continuous time periodic signal with period T, then $y(t) = x(2t)$ will also be periodic with period $2T$.
2. Sum of two continuous time periodic signals may or may not be periodic.
3. Sum of two discrete time periodic signals may or may not be periodic.

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

Q.15 In the graph shown below, which one of the following express $v(t)$?



(a) $(2t + 6)[u(t - 3) + 2u(t - 4)]$
(b) $(-2t - 6)[u(t - 3) + u(t - 4)]$
(c) $(-2t + 6)[u(t - 3) + u(t - 4)]$
(d) $(2t - 6)[u(t - 3) - u(t - 4)]$

Q.16 Which one of the following relation is not correct?

(a) $f(t)\delta(t) = f(0)\delta(t)$

(b) $\int_{-\infty}^{\infty} f(t)\delta(t-\tau)\,dt = f(\tau)$

(c) $f(t) * \delta(t-\tau) = f(t-\tau)$

(d) $\int_{-\infty}^{\infty} \delta(at)\,dt = 1$

Q.17 Which of the following signals are periodic?

1. $\cos\left(\frac{\pi}{3}n\right) + \sin\left(\frac{\pi}{3}n\right)$
2. $\cos\left(\frac{1}{2}n\right) + \cos\left(\frac{1}{3}n\right)$
3. Even $\{\cos(4\pi t)u(t)\}$
4. Even $\{\sin(4\pi t)u(t)\}$

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

Q.18 The power in the signal

$$s(t) = 8\cos\left(20\pi t - \frac{\pi}{2}\right) + 4\sin(15\pi t) \text{ is}$$

(a) 40 (b) 41
(c) 42 (d) 82

Q.19 **Statement (I):** The total energy of an energy signal falls between the limits 0 and ∞.

Statement (II): The average power of an energy signal is zero.

(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

Q.20 The signal $x(t) = A\cos(\omega_0 t + \phi)$ is

(a) an energy signal
(b) a power signal
(c) an energy as well as a power signal
(d) neither an energy nor a power signal

Q.21 Double integration of a unit step function would lead to

(a) an impulse (b) a parabola
(c) a ramp (d) a doublet

Q.22 If $\int_{-\infty}^{\infty} e^{3\left(\frac{t}{2}-1\right)} . \sin\frac{\pi t}{8\beta} . \delta(2-t) = \frac{-1}{\sqrt{2}}$.

Then the maximum value of β is

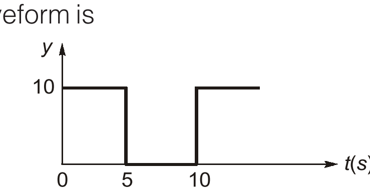
(a) -1 (b) $\frac{1}{5}$

(c) $\frac{1}{13}$ (d) $\frac{1}{21}$

Q.23 For a periodic waveform to be half-wave symmetric, it must be represented by a function satisfying

(a) $f(t) = f(t + T/2)$ (b) $f(t) = -f(t + T/2)$
(c) $f(t) = f - (-t)$ (d) $f(t) = f(-t)$

Q.24 In the given figure, the effective value of the waveform is



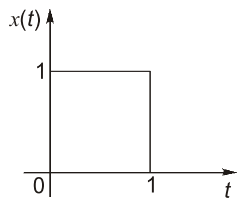
(a) 5.0 (b) 2.5
(c) $\sqrt{2.5}$ (d) $\sqrt{50}$

Q.25 Consider the sequence

$$x[n] = [-4 - j5 \quad \underset{\uparrow}{1 + j2} \quad 4]$$

The conjugate anti-symmetric part of the sequence is

Q.34 An LTI system has step response $(1 - e^{-t})\, u(t)$. The response of the system for following input $x(t)$ at $t = 2$ is________.



Multiple Select Questions (MSQ)

Q.35 For which of the following function(s) the time scaling operation will effect its original nature of the function:

(a) $\delta(t)$
(b) $u(t)$
(c) $r(t)$
(d) A rectangular pulse within finite duration.

Q.36 A discrete system with input $x[n]$ and output $y[n]$ are related by

$$y[n] = \sum_{n=-\infty}^{\infty} x[n]e^{-j\omega n}$$

The system is

(a) unstable (b) stable
(c) time variant (d) time invariant

Q.37 Consider a continuous time signal

$x(t) = 2\cos\left(\frac{\pi t}{4}\right) * \delta\left(\frac{t}{2} - 1\right)$. Then for which value of 't', signal $x(t)$ is zero.

(a) $t = 0$ (b) $t = 2$
(c) $t = 1$ (d) $t = 4$

Q.38 Consider a discrete-time periodic signal $x[n] = \begin{cases} 1, & 0 \le n \le 7 \\ 0, & 8 \le n \le 9 \end{cases}$ with period of $N = 10$. A function $y[n]$ is defined as $y[n] = \xi[n] - \xi[n-1]$, then the correct options regarding $y[n]$ are

(a) period $N = 10$
(b) period $N = 8$
(c) $y[n] = \{1,0,0,0,0,0,0,0,-1,0\}$ for one time period
(d) $y[n] = \{1,0,0,0,0,0,-1,0\}$ for one time period

■■■■

Answers Basics of Signals and Systems

1. (c)	2. (c)	3. (b)	4. (d)	5. (a)	6. (a)	7. (a)	8. (a)	9. (c)
10. (d)	11. (a)	12. (b)	13. (c)	14. (d)	15. (d)	16. (d)	17. (c)	18. (a)
19. (b)	20. (b)	21. (b)	22. (b)	23. (b)	24. (d)	25. (a)	26. (a)	27. (c)
28. (a)	29. (8)	30. (4)	31. (4)	32. (24)	33. (0)	34. (0.232)	35. (a,c,d)	36. (b,c)
37. (a,d)	38. (a,c)							

Explanations Basics of Signals and Systems

1. (c)

Since $f(t)u(t) = f(t)$ for $t > 0$ also we know $u(t - t_0) = 1$, for $t > t_0$

Here in right side shifting that means $t_0 > 0$

$\therefore$ by property on shifting right side,

$$f(t)\, u(t) = \xrightarrow[\text{shifting RHS by } t_0]{\text{on}} f(t - t_0)\, u(t - t_0)$$

2. (c)

For discrete time system,

$$\delta(n) = u(n) - u(n-1)$$

For continuous time system,

$$\delta(t) = \frac{d}{dt}u(t)$$

3. (b)

Since, for unit impulse, response is unit step i.e. transfer function is integrator.

$$\therefore \quad y(t) = \int_{-\infty}^{t} e^{-at}\, u(t) \qquad u(t) = \begin{cases} 1, & t > 0 \\ 0, & \text{elsewhere} \end{cases}$$

$$= \int_{0}^{t} e^{-at}\, dt = \frac{1}{a}(1 - e^{-at})$$

4. (d)

$$d(t) = \frac{d}{dt}u(t)$$

$$\text{Impulse response} = \frac{d}{dt}((1-e^{-\alpha t})u(t))$$

$$= \frac{d}{dt}(u(t)-u(t)e^{-\alpha t})$$

$$= \delta(t)-\delta(t)e^{-\alpha t}+\alpha e^{-\alpha t}u(t)$$

$\because \quad f(t)\,\delta(t) = f(0)\,\delta(t)$

$\therefore$ Impulse response $= \alpha e^{-\alpha t}\,u(t)$

5. (a)

For even function, $f(t) = f(-t)$

For odd function, $f(t) = -f(-t)$

6. (a)

Properties :

For continuous system

$$\delta(at) = \frac{1}{|a|}\delta(t)$$

For discrete system

$$\delta[an] = \delta[n]$$

7. (a)

$$x_1(t) = 2\sin\pi t + \cos 4\pi t$$

$$\therefore \quad \omega_1 = \frac{\pi}{1}$$

$$\omega_2 = \frac{4\pi}{1}$$

$$\omega_0 = \text{HCF}(\omega_1, \omega_2)$$

$$= \text{HCF}\left(\frac{\pi}{1}, \frac{4\pi}{1}\right) = \pi$$

$$\therefore \quad T = \frac{2\pi}{\omega_0} = \frac{2\pi}{\pi} = 2$$

$$x_2(t) = \sin 5\pi t + 3\sin 13\pi t$$

$$\omega_1 = \frac{5\pi}{1}; \quad \omega_2 = \frac{13\pi}{1}$$

$$\omega_0 = \text{HFC}(5\pi, 13\pi)$$

$$\omega_0 = \pi$$

$$\therefore \quad T = \frac{2\pi}{\omega_0} = \frac{2\pi}{\pi} = 2$$

$\therefore$ Both are periodic.

8. (a)

Energy signal: $E \neq \infty$, $P = 0$,

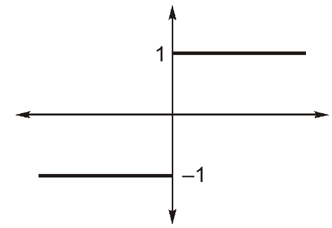
where E is energy and P is average power.

9. (c)

Power signal : $E = \infty$, $P \neq \infty$

10. (d)

Signum function is



$$2u(t)-1 = \begin{cases} 1, & t>0 \\ -1, & t<0 \end{cases}$$

$$u(t) = 1, \quad t>0$$
$$= 0, \quad \text{elsewhere}$$

11. (a)

The collective signal is periodic with period

$$= \text{LCM}\left(\frac{\pi}{2}, \frac{2\pi}{5}\right) = 2\pi\,.$$

Average value of a sinusoidal signal = 0.

$$V_{\text{avg.}} = \frac{1}{T}\int_0^T (v_1(t)+v_2(t))\,dt$$

$$= \frac{1}{T}\int_0^T (v_1(t)\,dt + \frac{1}{T}\int_0^T v_2(t)\,dt$$

$$= V_{\text{avg}_1} + V_{\text{avg}_2} = 0$$

12. (b)

Only complex exponential are periodic.

$$x_2(t) = e^{t(j+1)} = e^{jt}\,e^{t}$$

(because of this term x_2(t) is non-periodic)

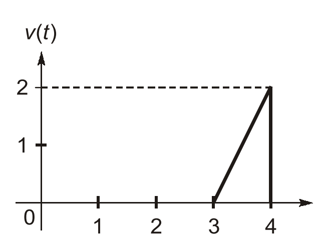
13. (c)

If a continuous time signal can take on any value in the continuous interval $(-\infty, \infty)$ then this signal is known as analog signal.

14. (d)

- If $x(t)$ is periodic with time period T, then $y(t) = x(2t)$ will be periodic with time period $T/2$.
- Sum of two discrete time periodic signals is always periodic.

15. (d)



v(t) consist 1 Ramp and 1 negative step,
Hence Ramp (1) having slope = 2

So $\quad \text{Ramp}(1) = 2\{r(t-3) - r(t-4)\}$

$\text{step}(2) = -2u(t-4)$

So, $\quad v(t) = 2r(t-3) - 2r(t-4) - 2u(t-4)$

$= 2(t-3)\,u(t-3) - 2(t-4)u(t-4) - 2u(t-4)$

$= 2(t-3)\,u(t-3) - 2(t-3)u(t-4)$

$= (2t-6)\,\{u(t-3) - u(t-4)\}$

16. (d)

$$\int_{-\infty}^{\infty} \delta(at)\,dt = \frac{1}{a}$$

Since, $\quad \delta(at) = \frac{1}{|a|}\delta(t)$

17. (c)

1. $\cos\left(\frac{\pi}{3}n\right) + \sin\left(\frac{\pi}{3}n\right) \Rightarrow$ periodic

   $\text{Period} = \frac{2\pi \times 3}{\pi} = 6$

2. $\cos\left(\frac{1}{2}n\right) + \cos\left(\frac{1}{3}n\right) \Rightarrow$ non-periodic

3. Even $\{\cos(4\pi t)u(t)\}$

   $= \frac{\cos(4\pi t)\,u(t) + \cos(-4\pi t)u(-t)}{2}$

   $= \frac{\cos 4\pi t}{2} \Rightarrow$ Periodic

4. Even $\{\sin(4\pi t)u(t)\}$

   $= \frac{\sin(4\pi t)u(t) + \sin(-4\pi t)u(-t)}{2} \Rightarrow$ non-periodic

18. (a)

Given: $s(t) = 8\cos\left(20\pi t - \frac{\pi}{2}\right) + 4\sin(15\pi t)$

$s(t) = 8\sin 20\pi t + 4\sin 15\pi t$

When both the sinusoidal signal having different frequency. Then overall power $(P) = P_1 + P_2$

$$P = \frac{8^2}{2} + \frac{4^2}{2} = 40$$

19. (b)

Energy of any signal is given by

$$E = \int_{-\infty}^{\infty} \left|x^2(t)\right| dt$$

and power of a signal is given by

$$P = \lim_{T\to\infty} \int_{-T/2}^{T/2} \frac{1}{T}\left|x^2(t)\,dt\right|$$

For energy signal, Energy is finite

$\therefore \quad P = \lim_{T\to\infty} \frac{E}{T}$

$P = \frac{E}{\infty} = 0$

$\rightarrow$ All the finite duration and bounded signals are energy signals.

Hence, statements (I) and (II) are correct but statement (II) is not correct explanation of statement (I).

20. (b)

$$x(t) = A\cos(\omega_0 t + q)$$

this is periodic signal and according to definition, all periodic signals are power signal.

Here, $\quad \text{Power} = \left(\frac{A}{\sqrt{2}}\right)^2 = \frac{A^2}{2}$

21. (b)

$\int_t u(\tau)d\tau = r(t) \quad$ Ramp

$\int_t r(\tau)\,d\tau = p(t) \quad$ Parabola

22. (b)

$$\delta(2-t) = \delta(t-2)$$

$$f(t) = e^{3\left(\frac{2}{2}-1\right)}.\sin\frac{\pi(2)}{8\beta}$$

$$= e^{3(1-1)}\sin\frac{\pi}{4\beta} = \frac{-1}{\sqrt{2}}$$

$$\sin\frac{\pi}{4\beta} = \frac{-1}{\sqrt{2}}$$

$$\beta = \frac{1}{5}, \frac{1}{13} \quad \text{and} \quad \beta = -1$$

$$\beta_{max} = \frac{1}{5}$$

23. (b)

For half wave symmetry

$$f(t) = -f\left(t + \frac{T}{2}\right) = -f\left(t - \frac{T}{2}\right)$$

24. (d)

Effective value = rms value

$$\text{Here} = \sqrt{\frac{1}{10}\int_0^5 (10)^2\,dt} = \sqrt{50}$$