

2025

ELECTRONICS — HONOURS

Paper : DSE-A-3 and DSE-A-4

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

DSE-A-3

(Basic VLSI Design)

Full Marks : 50

Answer *question no. 1* and *any four* questions from the rest.

1. Answer *any ten* questions :

1×10

- (a) The n-MOS transistor is made up of —
- (i) n-type source, p-type drain and p-type bulk
 - (ii) n-type source, n-type drain and p-type bulk
 - (iii) p-type source, n-type drain and n-type bulk
 - (iv) p-type source, p-type drain and n-type bulk.
- (b) Medium scale integration has _____.
- (i) ten logic gates
 - (ii) fifty logic gates
 - (iii) hundred logic gates
 - (iv) thousand logic gates.
- (c) VLSI technology uses _____ to form integrated circuit.
- (i) buffers
 - (ii) switches
 - (iii) diodes
 - (iv) transistors.
- (d) Which type of CMOS circuits are better?
- (i) p-well
 - (ii) n-well
 - (iii) Both p-well and n-well
 - (iv) None of these.
- (e) What are the advantages of BiCMOS?
- (i) Higher gain
 - (ii) High frequency characteristics
 - (iii) Better noise characteristics
 - (iv) All of these.

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(2184+2185)

- (f) The difficulty in achieving high doping concentration leads to _____.
- (i) error in concentration
 - (ii) error in variation
 - (iii) error in doping
 - (iv) distribution error.
- (g) In basic inverter circuit, _____ is connected to ground.
- (i) body
 - (ii) drain
 - (iii) gate
 - (iv) source.
- (h) α is used for scaling
- (i) linear dimensions
 - (ii) supply voltage (V_{dd})
 - (iii) oxide thickness
 - (iv) non-linear properties.
- (i) As die size shrinks, the complexity of making the photomasks _____.
- (i) increases
 - (ii) decreases
 - (iii) remains the same
 - (iv) cannot be determined.
- (j) What is the design flow of VLSI system?
- (1) architecture design
 - (2) market requirement
 - (3) logic design
 - (4) HDL coding.
- (i) (2)-(1)-(3)-(4)
 - (ii) (4)-(1)-(3)-(2)
 - (iii) (3)-(2)-(1)-(4)
 - (iv) (1)-(2)-(3)-(4).
- (k) In CMOS logic circuit the nMOS transistor acts as
- (i) load
 - (ii) pull up network
 - (iii) pull down network
 - (iv) not used in CMOS circuits.
- (l) Which one of the following is volatile in nature?
- (i) ROM
 - (ii) EROM
 - (iii) PROM
 - (iv) RAM.
2. (a) Write the differences between CMOS and bipolar technologies.
- (b) Explain, why a p-MOS transistor is used in the pull-up network.
- (c) What are the different layers in MOS transistors?
- (d) What is channel length modulation?
- (e) What is body effect?

2+2+2+2+2

(3)

D(6th Sm.)-Electronics-H/DSE-A-3 & DSE-A-4/CBCS

3. (a) What is Stick Diagram?
(b) What are the uses of stick diagram?
(c) Give the various color coding used in stick diagram.
(d) Define threshold voltage in CMOS. 2+2+4+2
4. (a) Compare Latches vs. Register.
(b) Discuss the circuit diagram of CMOS clocked S-R flip-flop.
(c) Explain propagation delay in static S-R flip-flop. 2+4+4
5. (a) What are two components of power dissipation?
(b) What is Verilog?
(c) Mention different models used in Verilog.
(d) How are Verilog and VHDL different from each other? 2+2+1+5
6. (a) Draw the general circuit diagram of an n-MOS inverter and explain its operation. Also draw the typical voltage transfer characteristic (VTC) curve for it showing all the critical voltages on the curve.
(b) Define Elmore's constant. (2+3+3)+2
7. (a) Discuss different capacitances of MOSFET.
(b) Discuss DC characteristics of a CMOS inverter.
(c) Write a short note on 'Noise Margin' in CMOS circuit. 4+4+2
8. (a) Distinguish between static and dynamic logic circuits.
(b) What is meant by a transmission gate?
(c) Draw the lumped RC equivalent circuit of a chain of four pass transistor driving a capacitive load.
(d) Implement Ex-OR gate using pass transistor. 2+2+3+3

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DSE-A-4

(Digital Signal Processing)

Full Marks : 50

Answer *question no. 1* and *any four* questions from the rest.1. Answer *any ten* questions :

1×10

- (a) The system $y(n) = \frac{1}{3} [x(n+1) + x(n) + x(n-1)]$ represents
- | | |
|---------------------------|----------------------|
| (i) moving average filter | (ii) identity system |
| (iii) unit delay system | (iv) median filter. |
- (b) A static discrete-time system is
- | | |
|----------------------------|-------------------------|
| (i) memory-less | (ii) with finite memory |
| (iii) with infinite memory | (iv) none of these. |
- (c) The discrete-time Fourier transform of $\delta(n)$ is
- | | |
|---------------------|------------------------------|
| (i) 1 | (ii) $\frac{1}{e^{j\omega}}$ |
| (iii) $e^{j\omega}$ | (iv) none of these. |
- (d) Which DFT property denotes, $x(n-m) \rightarrow \exp(-j2\pi km)X(k)$?
- | | |
|---------------------|--------------------|
| (i) Linearity | (ii) Time shifting |
| (iii) Time reversal | (iv) Periodicity. |
- (e) The width of the main lobe in rectangular window spectrum is
- | | |
|------------------------|-------------------------|
| (i) $\frac{16\pi}{N}$ | (ii) $\frac{8\pi}{N}$ |
| (iii) $\frac{4\pi}{N}$ | (iv) $\frac{2\pi}{N}$. |
- (f) In 8-point DFT, the value of twiddle factor W_8^1 is
- | | |
|--------------------------|--------------------------|
| (i) 1 | (ii) j |
| (iii) $-0.707 - j 0.707$ | (iv) $0.707 - j 0.707$. |
- (g) In an N-point sequence, if $N = 8$, the total number of complex additions and complex multiplications using radix-2 FFT are
- | | |
|------------------|-----------------|
| (i) 8 and 4 | (ii) 64 and 32 |
| (iii) 160 and 80 | (iv) 24 and 12. |

(h) The function $F(s) = \frac{s}{s^2 + \omega^2}$

- (i) has poles which lie on the left half of s -plane.
- (ii) has poles which lie on the right half of s -plane.
- (iii) has poles which lie on the imaginary axis of s -plane.
- (iv) has no poles.

(i) The poles of the normalized Butterworth transfer function

- (i) symmetrically lie on a unit circle in s -plane with angular spacing of π/N .
- (ii) asymmetrically lie on a unit circle in s -plane with angular spacing of π/N .
- (iii) symmetrically lie on a unit circle in s -plane with angular spacing of $2\pi/N$.
- (iv) asymmetrically lie on a unit circle in s -plane with angular spacing of $2\pi/N$.

(j) Raised-cosine window is also called

- (i) Blackman window
- (ii) Hanning window
- (iii) Rectangular window
- (iv) Hamming window.

(k) Which of the following filters cannot be designed using impulse invariance method?

- (i) Low pass
- (ii) Band pass
- (iii) Low pass and Band pass
- (iv) High pass.

(l) In Gibbs phenomenon,

- (i) Finding an FIR Filter is possible
- (ii) It approximates $H(\omega)$ to truncate the infinite series at $n = (N - 1)/2$
- (iii) Abrupt truncation of the series will lead to oscillations both in pass band and in stop band
- (iv) All of the above.

2. (a) Perform multiplication of discrete time signals, $x_1(n) = \{ 2, 2, 1, 2 \}$ and $x_2(n) = \{ -2, -1, 3, 2 \}$.

(b) Test the stability of LTI system whose impulse response is $h(n) = 0.2^n u(-n) + 3^n u(-n)$.

(c) Find the Fourier transform of the discrete-time signal

$$x(n) = \begin{cases} 1, & 0 \leq n \leq 4 \\ 0, & \text{otherwise} \end{cases}$$

(d) Test the causality of the system, $y(n) = nx(n)$.

2+2+4+2

3. (a) Write a difference equation that characterizes a system whose frequency response is

$$H(\omega) = \frac{1 - e^{-j\omega} - 3e^{-j2\omega}}{1 + \left(\frac{1}{3}\right)e^{-j\omega} + \left(\frac{1}{6}\right)e^{-j2\omega}}$$

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- (b) State BIBO stability criterion.
- (c) Check the stability of the system defined by, $y(n) = a x(n - 7)$. 4+2+4
4. (a) What is the relation between discrete-time Fourier transform (DTFT) and DFT?
 (b) What is twiddle factor?
 (c) State the periodicity and the time reversal properties of DFT.
 (d) Compute the IDFT of the four-point sequence
 $X(k) = \{6, -2 + 2j, -2, -2 - 2j\}$. 2+1+(2+2)+3
5. (a) Why FFT is required?
 (b) What is butterfly diagram?
 (c) Arrange the 8-point sequence $x(n) = \{2, 2, 2, 2, 1, 1, 1, 1\}$ in bit reversed order.
 (d) Compute 8-bit radix-2 DIF FFT of the sequence $x(n) = \{2, 2, 2, 2, 1, 1, 1, 1\}$. 1+2+2+5
6. (a) What are the factors that influence the choice of structure of realization of an LTI system?
 (b) What is the necessary and sufficient condition for the linear phase characteristic of an FIR filter?
 (c) What is the reason that FIR filter is always stable?
 (d) Write the steps involved in FIR filter design.
 (e) Compare the Hanning and Hamming windows. 2+2+1+3+2
7. (a) Name different IIR filter realisation method.
 (b) What is the main objective of impulse invariant transformation?
 (c) For the analog transfer function

$$H(s) = \frac{1}{(s+1)(s+2)}$$

determine system function $H(z)$ using impulse invariant transformation technique. Assume sampling interval $T = 1s$.

- (d) What is the relation between digital and analog frequency in bilinear transformation? 2+2+4+2
8. (a) What is Hurwitz polynomial in network synthesis?
 (b) Write down the properties of Positive Real function.
 (c) What is the first form of Cauer LC network?
 (d) A driving point impedance is given by

$$Z(s) = \frac{s(s^2 + 4)(s^2 + 6)}{(s^2 + 1)(s^2 + 5)}$$

Obtain the LC representation of the first form of Cauer network. 2+2+2+4