Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SECOND SEMESTER M.TECH DEGREE EXAMINATION (R,S), MAY 2024

VLSI AND EMBEDDED SYSTEMS

(2021 Scheme)

Course Code: 21VE206-A

Course Name: High Speed Digital Design

Max. Marks: 60 **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Define effective length of a signal. Illustrate and substantiate how rise time of a signal classifies a system as lumped or distributed.
2. A signal source is connected through a transmission line of impedance 50 Ω connected to a 50 Ω terminator. At the terminating end, a sensing probe with a 1000 Ω resistor is connected, the other end of which leads to a 50 Ω terminated output and then to a high speed sampling scope. Compute the expected rise time degradation when the probe under test behaves as a simple capacitive load of 10 pF. Determine the composite rise time at the probe under test if the signal has a rise time of 700 ps.
3. List any three methods by which operating margins can be observed in high speed circuits.
4. Derive the characteristic impedance of an ideal transmission line at high speeds.
5. With the help of a diagram, describe the relevance of middle terminators.
6. With the help of figures, explain series inductance offered by vias.
7. Explain, using a circuit and waveforms, timing margin associated with clock distribution.
8. Explain how uniform voltage distribution is ensured with reference to the resistance and inductance of power distribution wiring.

PART B

(Answer one full question from each module, each question carries 6 marks)

MODULE I

9. Using appropriate illustrations and equations explain the internal dissipation and drive circuit dissipation powers in a high speed digital circuit. (6)

OR

10. A large bus is connected for the shared memory sub-system of a parallel (6)

computer. The bus connects 16 small CPUs any of which may access an 8-bit wide RAM. The bus is implemented using 47Ω controlled impedance traces that are 10 inches long. The bus propagation length is much shorter than the rise time of a gate used. Hence, no terminators are used at the ends of the bus. Each bus driver is able to drive 16 other circuits. The maximum propagation delay of each transceiver is 9 ns and the bus is to be operated at a cycle of 30 ns (33 MHz). Compute the load capacitance on each trace and the drive resistance of the three-state output loads. Compute the rise time of the bus as well as the power dissipation associated with each driver.

MODULE II

11. Elaborate on the three kinds of special probing fixtures used to measure high frequency signals in digital systems. (6)

OR

12. With the help of proper illustrations and expressions, explain the rise time and bandwidth of oscilloscope. Draw the electrical model of an oscilloscope with R_{source}=100Ω, L=200 nH, C=10 pF and R_{shunt}=10 MΩ. Compute the LC time constant and thereby the rise time for a critically damped two-pole circuit depicted by the given electrical model. (6)

MODULE III

13. Paraphrase meta-stability. explain, with the help of figures, waveforms and equations, how meta-stability is measured, its causes and how to prevent its occurrence. (6)

OR

14. A semiconductor company built their first prototype of a high speed processor. They used point-to-point wiring to reduce the cost and delay of making PCBs. The prototype has the following specifications:
Gates = 6000, signal nets = 2000, knee frequency = 250 MHz, rise time = 2 ns, speed of operation = 85 ps/in, average net length = 4 in, average wire height above ground = 0.2 in, separation between wires = 0.1 in, wire size = 0.01 in, series resistance = 30 Ω, capacitance = 15 pF, step voltage = 3.7 V. (6)
Using the above information, show that transmission lines are superior to ordinary point-to-point wiring at high speeds in terms of signal distortion and cross talk.

MODULE IV

15. Using appropriate figures and equations, explain skin effect and its mechanics at high speeds. (6)

OR

16. Compare and contrast the features of low–loss and lossy transmission (6)

lines. State the unique properties of lossless transmission lines.

MODULE V

17. Analyze and compare the rise time, drive current, drive impedance and power dissipated of an end terminated and a source terminated transmission lines. Illustrate how the received voltage is a delayed copy of the transmitted waveform in a source terminated line. (6)

OR

18. With help of appropriate diagrams and equations, estimate the mutual inductance and cross talk in connectors. State the five rules that determine connector behavior at high speeds. (6)

MODULE VI

19. Paraphrase delay adjustments at high frequencies and elaborate on the different types of delays using apt illustrations. (6)

OR

20. State the functions of a power system. Elaborate the three power rules applicable to high speed circuits. Illustrate and explain how a power and ground plane system is superior to a single plane power system. (6)

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