2019

B.Sc. (Honours)

5th Semester Examination

ELECTRONICS

Paper - DSE-1T

Full Marks : 40 Time : 2 Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

[Semiconductor Fabrication and Characterization (Theory)]

1. Answer any *five* questions from the following : 2×5=10

(i) What is the difference between crystalline materials and amorphous materials ? 2

(ii) What is an epitaxial growth ? 2

[Turn Over]

(iii) Mention the uses of scanning electron microscope. 2

(iv) How can you grow a thin oxide layer ? 2

(v) Establish Fick's diffusion equation. 2

(vi) What is 'class 100' room ? 2

(vii) Explain λ-based design rules for the layout of VLSI circuits. 2

(viii) 'The choice of crystal orientation is important for MOS devices but that is not so critical for a bi-polar transistor fabrication.'—Why ? 2

2. Answer any *four* questions from the following : 5×4=20

(i) Describe Czochralski process of crystal growth to obtain single crystal of silicon. 5

(ii) Explain with a schematic diagram for the charges associated with thermally oxidized silicon. 5

(iii) 'A two-step diffusion process is commonly used in IC processing'—explain it. What is an extrinsic diffusion ? 2½+2½

(iv) Give the working principle of transmission electron microscope. 5

(v) Mention the features that must be considered in metallization scheme in VLSI ? Describe the problems arising from aluminium deposition. 2½+2½

(vi) Describe the fabrication of an integrated circuit resistor. 5

3. Answer any *one* question from the following : 10×1=10

(i) (a) What do you mean by isotropic and anisotropic etching ?

Calculate the Al average etch rate uniformity on a 200-mm diameter silicon wafer, assuming the etch rates at the center, left, right, top and bottom of the wafer are 750, 812, 765, 743 and 798 nm/min respectively.

[Turn Over]

(b) Mention the etchants used for silicon and aluminum etchings. (1½+1½+3)+(2+2)

(b) Describe the fabrication of an NMOS transistor with schematic diagrams. 10

[Power Electronics (Theory)]

1. Answer any *five* questions from the following : 2×5=10

(i) For high frequency applications, which one is preferred MOSFET or IGBT and why ? 1+1

(ii) What is hard switching of thyristor ? 2

(iii) Define Latching current and Holding current. 1+1

(iv) What are the differences between power diode and signal diode ? 2

(v) What losses occur in a thyristor during working condition ? 2

(vi) What is the function of free wheeling in controlled rectifier ? 2

(vii) What is meant by natural commutation ? 2

(viii) What is commutation angle or overlap angle ? 2

[Turn Over]

2. Answer any *four* questions from the following : 5×4=20

(i) Write briefly different methods of turning on thyristor. 5

(ii) What is stepup and step down chopper ? 2½+2½

(iii) Draw the V-I characteristic of a SCR and show its different region. 2½+2½

(iv) Explain 'Turn ON' time of thyristor. 5

(v) What are the advantages and disadvantages of Gate Turn Over (GTO) thyristor. 5

(vi) What is an inverter ? Why thyristor is not used for inverter ? 2½+2½

3. Answer any *one* question from the following. 10×1=10

(i) Draw two transistor models of SCR and derive an expression for diode current. Why Si is used to fabricate SCR ? 8+2

(ii) Derive an expression for the average output voltage in terms of input dc voltage & duty cycle of thyristor controlled rectifier. 5+5

[Turn Over]

[Numerical Techniques (Theory)]

1. Answer any *five* questions from the following : $2\times5=10$

(i) Round-off the following numbers up to six significant figures : $4\times\frac{1}{2}=2$

(a) 24.56496

(b) 27.483554

(c) 30.034653

(d) 21.565345

(ii) What are the limitations of using Newton-Raphson method ? 2

(iii) How can you improve the accuracy of a numerical integration process ? 2

(iv) Find the relative error in x_A, when $x_T = \frac{1}{3}$ and $x_A = 0.333$. x_T and x_A are the true value and approximate value of a number respectively. 2

(v) Round off the following numbers correct upto four decimal places : $4\times\frac{1}{2}=2$

(a) 2.587682

(b) 8.75945

(c) 0.009998

(d) 4.385622.

(vi) Using Simpson's $\frac{1}{3}$ formula, compute $\int_0^{10} f(x)dx$ for the values of f(x) given below : 2

x	0	5	10
f(x)	1.0	1.6	3.8

(vii) Construct a linear interpolation for f(x) with f(1) = 3 and f(2) = –5. 2

(viii) Find the first approximation of a root of $x^3+3x-1=0$, by Newton-Raphson method taking $x_0=0$. 2

[Turn Over]

2. Answer any *four* questions from the following : 5×4=20

(i) Derive the iterative formula for Regula-Falsi method. 5

(ii) Apply the 4^{th} order Runge-Kutta method to solve $\frac{dy}{dx} = x^2 + y^2,\ y(0) = 1.$

Take step size h = 0.1 and determine approximations to y(0.1) and y(0.2) correct to four decimal places. 2½+2½

(iii) Describe Bisection Method to solve the equation $f(x) = 0$ when a root lies between a and b. What is the draw back of this method ? 3+2

(iv) Derive Newton's forward interpolation formula. 5

(v) Evaluate $\int_0^1 \frac{dx}{1+x^2}$ using Simpson's $\frac{1}{3}$rd rule taking $h = \frac{1}{4}$. Use the result to compute the value of π. 2½+2½

(vi) Find by Lagrange's formula the interpolating polynomial which corresponds to the following data : 5

x	-1	0	2	5
f(x)	9	5	3	15

3. Answer any *one* question from the following : 10×1=10

(i) (a) Evaluate approximately by Trapezoidal rule, the integral.

$$\int_0^1 \left(4x - 3x^2\right) dx \text{ by taking } n = 10$$

(b) Write down the geometrical interpretation of Trapezoidal rule for numerical integration. 5+5

(ii) (a) Describe Gauss-Tordan iteration method to solve a system of linear equations.

(b) Solve the following system of equations by Gauss elimination method : 5+5

$$x_1 + 2x_2 - x_3 = 3$$
$$3x_1 - x_2 + 2x_3 = 1$$
$$2x_1 - 2x_2 + 3x_3 = 2$$

[Electrical Machines (Theory)]

1. Answer any *five* questions from the following : 2×5=10

(i) Why transformer rating is in kVA ? 2

(ii) Why fractional pitched winding is required than full pitch winding ? 2

(iii) What is critical resistance of a DC shunt generator ? 2

(iv) Write EMF equation of DC generator. 2

(v) What is the use of Interpole in DC machine ? 2

(vi) Write down the different starting methods of poly phase induction motor. 2

(vii) Explain torque-slip characteristics of induction motor with mathematical expression. 2

(viii) What happen when a DC supply is applied to a Transformer ? 2

[Turn Over]

2. Answer any *four* questions from the following : 5×4=20

(i) A 50-kVA 2400 : 240-V 60-Hz distribution transformer has a leakage impedance of 0.72+j0.92 Ω in the high-voltage winding and 0.0070+j0.0090 Ω in the low-voltage winding. At rated voltage and frequency, the impedance Z_φ of the shunt branch (equal to the impedance of R_c and jX_m in parallel) accounting for the exciting current is 6.32+*j*43.7 Ω when viewed from the low-voltage side. Draw the equivalent circuit referred to (a) the high-voltage side and (b) the low-voltage side, and label the impedances numerically. 2+2+1

(ii) With the instruments located on the high-voltage side and the low-voltage side short-circuited, the short-circuit test readings for the 50-kVA 2400 : 240-V transformer of 50-kVA 2400 : 240 V 60-Hz are 48 V, 20.8 A, and 617 W. An open-circuit test with the low-voltage side energized gives instrument readings on that side of 240 V, 5.41 A, and 186 W. Determine the efficiency and the voltage regulation at full load, 0.80 power factor lagging. 2½+2½

(iii) A permanent-magnet dc motor is known to have an armature resistance of 1.03 Ω. When

operated at no load from a dc source of 50 V, it is observed to operate at a speed of 2100 r/min and to draw a current of 1.25 A. Find (a) the torque constant, (b) the no-load rotational losses of the motor and (c) the power output of the motor when it is operating at 1700 r/min from a 48-V source. 1½+1½+2

(iv) A 25 kW 125 V separately-excited dc machine is operated at a constant speed of 3000 r/min with a constant field current such that the open-circuit armature voltage is 125 V. The armature resistance is 0.002 Ω. Compute the armature current, terminal power, and electromagnetic power and torque. 1+1½+1½+1

(v) A 60 kVA, 220 V, 50 Hz, single phase alternator has effective armature resistance of 0.016 ohm and an armature leakage reactance of 0.07 ohm. Compute the voltage induced in the armature when the alternator is delivering rated current at a load power factor of (a) unity (b) 0.7 lagging and (c) 0.7 leading. Draw the necessary phasor diagrams. 2½+2½

(vi) Write down the details ideas on "double revolving field theory" in single phase motor with

proper mathematical derivations and phasor diagrams. 5

3. Answer any *one* question from the following : 10×1=10

(i) (a) Explain the effect of armature reaction on different power factor loads of synchronous generator.

(b) Derive the emf equation of an alternator in case of synchronous generator.

(c) Compare the efficiency and operating power factor of single phase induction motor with three phase induction motor. 5+3+2

(ii) (a) From fundamentals, derive the EMF equation of a DC generator.

(b) With necessary diagram explain the speed control of dc shunt motor.

(c) Explain the elementary theory of ideal transformer. Why the core of transformer is laminated ? 2+1
