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5 SEM TDC PHY M 4

2014

(November)

PHYSICS

(Major)

Course : 504

(Electronics)

Full Marks : 60
Pass Marks : 24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer : 1×6=6

(a) Electron and hole concentration in an intrinsic semiconductor are n_i per cm^3. If acceptor impurities of N_A per cm^3 ($N_A >> n_i$) are introduced, the electron concentration per cm^3 will be

(i) n_i

(ii) $n_i + N_A$

(iii) $N_A - n_i$

(iv) n_i^2 / N_A

(b) Ripple frequency of the output waveform of a bridge rectifier when fed with a 50 Hz sine wave is

(i) 25 Hz

(ii) 50 Hz

(iii) 100 Hz

(iv) None of the above

(c) The voltage divider bias circuit is often used in amplifiers, because it

(i) limits the a.c. signal going to the base

(ii) makes the operating point almost independent of β

(iii) reduces the d.c. base current

(iv) reduces the cost of the circuit

(d) Generally the gain of a transistor amplifier falls at high frequencies due to the

(i) coupling capacitor at the output

(ii) coupling capacitor at the input

(iii) internal capacitance of the device

(iv) skin effect

(e) The frequency of oscillation of a crystal oscillator is

(i) proportional to the thickness of the crystal

(ii) inversely proportional to the thickness of the crystal

(iii) proportional to the mass of the crystal

(iv) independent of mass and thickness

(f) The Boolean expression $(\overline{A}+B)(A+B)$ when simplified yields to

(i) B

(ii) A

(iii) $\overline{B}$

(iv) $\overline{A}$

2. Answer the following : 2×6=12

(a) What is Fermi level? How does the doping concentration affect the position of Fermi level?

(b) The intrinsic resistivity of silicon at 27 °C is $2 \cdot 8 \times 10^3$ Ω-m. The electron and hole mobilities are 0·38 $m^2 V^{-1} s^{-1}$ and 0·18 $m^2 V^{-1} s^{-1}$ respectively. Calculate the intrinsic carrier density at the given temperature.

(c) A transistor is connected in the *C-E* configuration with a collector supply voltage of 8 V and a collector resistance of 800 Ω. If the voltage drop across the resistor is 0·5 V, find the base current. (Given $\alpha = 0{\cdot}96$)

(d) State a characteristic of common-collector amplifier. Mention the main purpose for which it is used.

(e) Show how an OP-AMP can be used as an integrator.

(f) Simplify the following expression with the help of K-map :

$$y = AB\overline{C} + A\overline{B}\overline{C} + ABC + A\overline{B}C + \overline{A}BC$$

3. (a) Draw the circuit diagram of a simple power supply using π-type filter and Zener diode. Explain the working of the filter section and Zener diode. 2+3+3=8

Or

Explain the terms 'barrier potential' and 'depletion region' as applied to a *p-n* junction. Write down the expression for voltage-current characteristic of a *p-n* junction. What is reverse saturation current? Why does it suddenly increase at a certain reverse voltage? 4+1+1+2=8

(b) What is meant by diffusion of charge carriers in a semiconductor? Define diffusion constant and give its unit. Write the expression for total hole current in presence of electric field E. What is Einstein's relationship? 2+2+1+1=6

4. (a) Derive an expression for the gain of an amplifier of gain A when subjected to negative feedback. Explain how the gain of an amplifier can be stabilized with the help of negative feedback. 3+3=6

Or

Draw the circuit diagram of a Class–B push-pull power amplifier and find an expression for its maximum efficiency. 1+5=6

(b) What do you mean by amplitude distortion and frequency distortion in amplifiers? 3

5. (a) Sketch the circuit of Wien bridge oscillator and find an expression for its frequency of oscillation. 1+4=5

(b) Discuss how a diode can be formed in a monolithic integrated circuit. 4

Or

What is a differential amplifier? Explain the term 'common-mode rejection ratio' of an OP-AMP. 1+3=4

6. *(a)* Draw a logic diagram to implement the Boolean expression

$$y = BC\overline{(AB + \overline{C})}$$

Also simplify this equation using Boolean rules and De Morgan's theorem. 2+2=4

(b) Draw the logic diagram of a full-adder and give its truth table. 2+1=3

(c) Show how NAND gates can be combined to achieve AND, OR and NOT operations. 3

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