CLASS TEST - 2016

Electronics Engineering

EC

Electronic Devices and Circuits

Date : 09/08/2016

ANSWERS

1.	(c)	7.	(d)	13.	(d)	19.	(b)	25.	(b)
2.	(c)	8.	(c)	14.	(a)	20.	(a)	26.	(d)
3.	(c)	9.	(c)	15.	(c)	21.	(d)	27.	(d)
4.	(b)	10.	(b)	16.	(b)	22.	(a)	28.	(a)
5.	(b)	11.	(b)	17.	(c)	23.	(b)	29.	(a)
6.	(b)	12.	(c)	18.	(b)	24.	(a)	30.	(d)

Explanations

1. (c)

$$\because \quad (\beta + 1) = \frac{I_{CEO}}{I_{CBO}} = \frac{0.6 \times 10^{-3}}{3 \times 10^{-6}} = 200$$

$$\therefore \quad \beta = 199$$

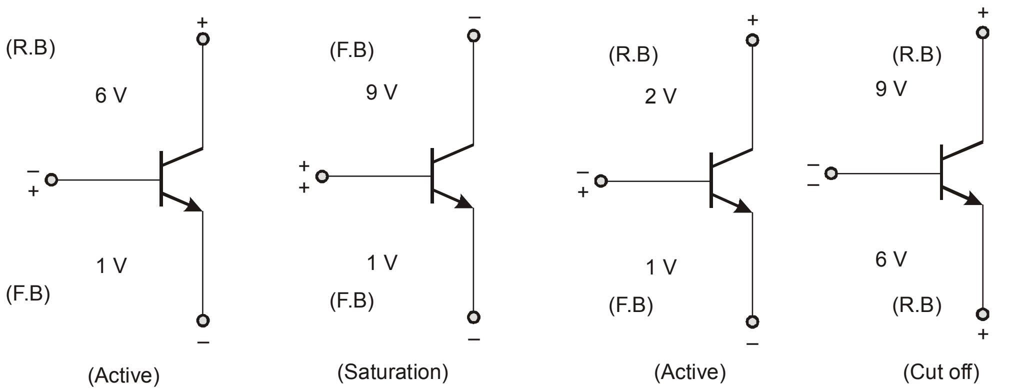
2. (c)

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$g_m = \frac{\partial I_D}{\partial V_{GS}} = -2\frac{I_{DSS}}{V_P}\left(1 - \frac{V_{GS}}{V_P}\right)$$

$$= \frac{-2I_{DSS}}{V_P}\sqrt{\frac{I_D}{I_{DSS}}} = \frac{-2}{V_P}\sqrt{I_{DSS}I_D}$$

3. (c)



4. (b)

$$E_{Fi} - E_F = kT\ln\left(\frac{N_A}{n_i}\right)$$

$$\left(\frac{0.3}{0.0259}\right) = \ln\left(\frac{N_A}{n_i}\right)$$

$$\therefore \quad N_A = n_i \exp\left(\frac{0.3}{0.026}\right) = 1.54 \times 10^{15}\ \text{cm}^{-3}$$

It is given in the question that the Fermi level lies below the intrinsic level thus, the type of doping will be acceptor type of doping.

5. (b)

6. (b)

7. (d)

$$I_D = \frac{10 - 0.7}{4.65 \times 10^3} = 2 \text{ mA}$$

$$r = \frac{V_T}{I_D} = \frac{25 \times 10^{-3}}{2 \times 10^{-3}}$$

$$= 12.5\ \Omega$$

8. (c)

$$\alpha = \alpha_T \cdot \gamma$$

$$\therefore \quad \gamma = \frac{\alpha}{\alpha_T} = \frac{0.96}{0.98} = 0.9796$$

9. (c)

$$E_F = E_v + kTl\,n\left(\frac{N_v}{N_A}\right)$$

for $E_F = E_v$ we get

$$N_v \approx N_A,$$

thus $N_A = N_v = 1.04 \times 10^{19}\ \text{cm}^{-3}$

10. (b)

11. (b)

$$E_{Max} = \frac{2\left(V_{b_i} + V_R\right)}{W} = \frac{2(5 + 0.7)}{2 \times 5.7 \times 10^{-6}}$$

$$= 10^6 = 1 \text{ MV/m}$$

12. (c)

$$\lambda = \frac{1.24}{E(eV)}\ \mu\text{m} = \frac{1.24}{1.42} = 0.873\ \mu\text{m}$$

13. (d)

$$f(E_c) = \frac{1}{1 + \exp\left(\frac{E_c - E_f}{kT}\right)} = \frac{1}{1 + \exp\left(\frac{0.36}{0.026}\right)} = 9.698 \times 10^{-7}$$

14. (a)

The equation for time dependence of excess carrier in reaching a steady-state is given as

$$\delta p(t) = g'\tau_{po}\left[1 - e^{-\frac{t}{\tau_p}}\right]$$

comparing the equation with the given data we get

$$g'\tau_{po} = 5 \times 10^{14}$$

$$\therefore \quad g' = \frac{5 \times 10^{14}}{10^{-7}} = 5 \times 10^{21}\ \text{cm}^{-3}s^{-1}$$

15. (c)

$\because$ The induced electric field given as

$$E_x = -\left(\frac{kT}{q}\right)\frac{1}{N_d(x)}\cdot\frac{dN_d(x)}{dx}$$

16. (b)

$$V_{po} = \frac{qa^2N_d}{2\varepsilon_{si}} = \frac{1.6\times10^{-19}(0.5\times10^{-4})^2\times(10^{16})}{2(11.7)(8.85\times10^{-14})}$$

$$= 1.93\text{ V}$$

17. (c)

$$V_{bi} = V_T\, ln\left(\frac{N_AN_D}{n_i^2}\right)$$

$$= 0.025\, ln\left(\frac{10^{16}\times10^{15}}{(1.5\times10^{10})^2}\right) = 0.613\text{ V}$$

$$W = \left\{\frac{2\varepsilon_{si}V_{bi}}{q}\left\{\frac{1}{N_A}+\frac{1}{N_D}\right\}\right\}^{\frac{1}{2}}$$

$$W = \left[\frac{2\times(11.7)(8.85\times10^{-14})(0.613)}{1.6\times10^{-19}}\times\left[\frac{1}{10^{16}}+\frac{1}{10^{15}}\right]\right]^{\frac{1}{2}}$$

$$= 9.33\times10^{-5}\text{ cm} = 0.933\ \mu\text{m}$$

18. (b)

$\because$

$$C' = \frac{\varepsilon_{si}}{W} = \frac{11.7\times8.85\times10^{-12}}{2\times10^{-6}}$$

$$= 51.77\ \mu\text{F/m}^2$$

19. (b)

The Hall voltage is negative in n-type semiconductor.

20. (a)

$$V_{bi} = V_T\, ln\left(\frac{N_AN_D}{n_i^2}\right)$$

$$= 0.026\, ln\left(\frac{10^{17}\times10^{14}}{(1.5\times10^{10})^2}\right)$$

$$= 0.637\text{ V}$$

21. (d)

$$n_i = \sqrt{N_c N_v}\,\exp\left(\frac{-E_g}{2kT}\right)$$

$$\frac{n_{i_1}}{n_{i_2}} = \frac{\exp\left(\frac{-E_{g_1}}{2kT}\right)}{\exp\left(\frac{-E_{g_2}}{2kT}\right)}$$

$$\frac{n_{i_1}}{n_{i_2}} = \exp\left[-\left[\frac{E_{g_1}-E_{g_2}}{2kT}\right]\right] = \exp\left[-\left[\frac{1.1-0.7}{2\times 0.026}\right]\right] = 4.56\times 10^{-4}$$

22. (a)

$$\phi_s = 2V_T\,ln\left(\frac{N_A}{n_i}\right) = 2\times 0.026\; ln\left(\frac{10^{16}}{1.5\times 10^{10}}\right) = 0.6973\text{ V}$$

23. (b)

$$C_{\min} = \frac{\varepsilon_{ox}}{t_{ox}+\left(\frac{\varepsilon_{ox}}{\varepsilon_{Si}}\right)x_{dT}} = \frac{(3.9)(8.85\times 10^{-14})}{(550\times 10^{-8})+\left(\frac{3.9}{11.7}\right)(3\times 10^{-4})}$$

$$= 3.273\text{ nF/cm}^2$$

24. (a)

$$\frac{D_n}{\mu_n} = V_T$$

$\therefore$ $D_n = \mu_n V_T$, now $L_n = \sqrt{D_n\tau_n}$

$\Rightarrow$ $L_n = \sqrt{\mu_n V_T \tau_n}$

$$= \sqrt{1300\times 0.025\times 5\times 10^{-7}}$$

$$= 4.112\times 10^{-3}\text{ cm}$$

$$= 41.12\ \mu\text{m}$$

25. (b)

$\because$ $$V_{sat} = \frac{L}{t} = \frac{2\times 10^{-4}}{20\times 10^{-12}}$$

$$= 10^7\text{ cm/sec}$$

26. (d)

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS}-V_T)^2$$

$$0.3\times 10^{-3} = \frac{1}{2}(5\times 10^{-6})\cdot 6(V_{GS}-0.6)^2$$

$$V_{GS} = 5.07\text{ V}$$

27. (d)

In a $p^+ n$ junction we can say

$$C \approx \left\{\frac{q\varepsilon_s N_d}{2(V_{bi}+V_R)}\right\}^{\frac{1}{2}}$$

or $$\left(\frac{1}{C}\right)^2 = \frac{2(V_{bi}+V_R)}{q\varepsilon_s N_d}$$

thus, $$\text{slope} = \frac{2}{q\varepsilon_s N_d}$$

now, $$\varepsilon_{si} = 11.7\times\varepsilon_0$$

$$q = 1.6\times10^{-19}$$

thus $$N_d = \frac{2}{q\times\varepsilon_{si}\times\text{slope}}$$

$$= \frac{2}{1.00\times10^{15}\times1.6\times10^{-19}\times11.7\times8.854\times10^{-14}}$$

$$N_d = 1.2\times10^{16}\text{ /cm}^3$$

28. (a)

$$\sigma = n_0 q\mu_n + p_0 q\mu_n$$

now, $$n_0 = \frac{n_i^2}{p_0}$$

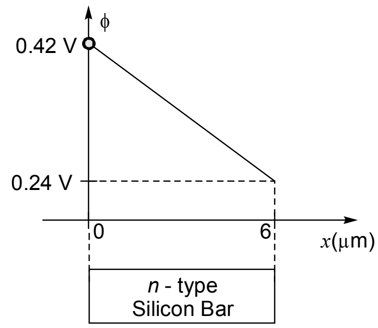
$\therefore$ $$\sigma = \frac{q\mu_n n_1^2}{p_0} + q\mu p_0$$

thus putting $$\frac{d\sigma}{dp} = 0$$

we get $$p_0 = n_i\left(\frac{\mu_n}{\mu_p}\right)^{\frac{1}{2}}$$

$$= 68\times10^{11}\text{ /cm}^3$$

29. (a)



$$\phi(x) = V_T \ln\left(\frac{N_D(x)}{n_i}\right)$$

$$\phi(0)-\phi(6\mu) = V_T \ln\left(\frac{N_D(0)}{N_D(6\mu)}\right)$$

$$\frac{N_D(0)}{N_D(6\mu)} = e^{(0.18/V_T)} \simeq 1015$$

30. (d)

We know that the capacitance of the reverse biased junction can be given as

$$C = \frac{C_{0j}}{\left(1+\frac{V_R}{V_j}\right)^{\frac{1}{2}}}$$

C = built in capacitance at reverse bias V_R.

C_{0j} = built in capacitance at reverse bias V_R = 0 V.

$$0.4 = \frac{1}{\left(1+\frac{5}{V_j}\right)^{\frac{1}{2}}}$$

$$V_j = 0.952 \text{ V}$$

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