XMUT204 ELECTRONIC DESIGN (MIDTERM TEST)

USEFUL FORMULAE AND INFORMATION

Constants

Atomic mass unit	amu	1.66×10^{-27} kg
Avogadro's number	NA	6.02×10^{23} mol^{-1}
Boltzmann constant	kB	1.38×10^{-23} J.K^{-1} = 8.62×10^{-5} eV.K^{-1}
Electron charge	e	1.6×10^{-19} C
Permeability of vacuum	μo	$4\pi \times 10^{-7}$ H.m^{-1}
Permittivity of vacuum	εo	8.85×10^{-12} F.m^{-1}
Plank's constant	h	6.626×10^{-34} J.s = 4.136×10^{-15} eV.s
Speed of light	c	2.99×10^{8} m.s^{-1}

For single crystal silicon:

Density ρ = 2.328 g.cm^{-3}

Relative atomic mass = 28.09

Electron mobility μ_e =1400 cm^2/Vs

Hole mobility μ_h = 450 cm^2/Vs

From the periodic table:

13	14	15
Boron 5 B 10.81	Carbon 6 C 12.01	Nitrogen 7 N 14.01
Aluminum 13 Al 26.98	Silicon 14 Si 28.09	Phosphorus 15 P 30.97
Gallium 31 Ga 69.72	Germanium 32 Ge 72.61	Arsenic 33 As 74.92
Indium 49 In 114.82	Tin 50 Sn 118.71	Antimony 51 Sb 121.76
Thallium 81 Tl 204.38	Lead 82 Pb 207.20	Bismuth 83 Bi 208.98

The E12 resistor series:

1.0	1.2	1.5	1.8	2.2	2.7	3.3	3.9	4.7	5.6	6.8	8.2

Conductivity & Resistivity:

Parameter	Formulae
Conductivity of Material, σ	$\sigma = ne\mu$
Resistivity of Material, R	$R = \frac{\rho L}{A} = \frac{L}{\sigma A}$

Diode:

Parameter	Formulae
Ebers-Moll equation for diode	$I_D = I_s\left(e^{V_{BE}/V_T} - 1\right)$
Diode Junction Built-in Potential	$V_0 = V_T Ln\left[\frac{N_A N_B}{(n_i)^2}\right]$ $(V_T = 0.025 \text{ at } 25°\text{C})$
Width of depletion region	$W = \sqrt{\frac{2\varepsilon(N_A + N_B)V_0}{eN_A N_B}}$
Forward current, ideal diode model	$I_F = \frac{V_{bias}}{R_{limit}}$
Forward current, practical diode model	$I_F = \frac{V_{bias} - V_F}{R_{limit}}$

Diode Applications:

Half-wave average value	$V_{avg} = \frac{V_p}{\pi}$
Peak half-wave rectifier output (silicon)	$V_{p(out)} = V_{p(in)} - 0.7$ V
Peak inverse voltage, half-wave rectifier	$PIV = V_{p(in)}$
Full-wave average value	$V_{avg} = \frac{2V_p}{\pi}$
Center-tapped full-wave output	$V_{out} = \frac{V_{sec}}{2} - 0.7$ V
Peak inverse voltage, center-tapped rectifier	$PIV = 2V_{p(out)} + 0.7$ V
Bridge full-wave output	$V_{p(out)} = V_{p(sec)} - 1.4$ V
Peak inverse voltage, bridge rectifier	$PIV = V_{p(out)} + 0.7$ V
Line regulation	$\text{Line Regulation} = \left(\frac{\Delta V_{out}}{\Delta V_{in}}\right) \times 100\%$
Load regulation	$\text{Load Regulation} = \left(\frac{V_{NL} - V_{FL}}{V_{FL}}\right) \times 100\%$
Wavelength of LED	$\lambda(nm) = 1240/E_g(eV)$
LED light spectra wavelengths and forward voltage (V_f)	Red: 610-760 nm ~ 1.6-2 V Orange: 590-610 nm ~ 2-2.1 V Yellow: 570-590 nm ~ 2.1-2.2 V Green: 500-570 nm ~ 1.9-4 V Blue: 450-500 nm ~ 2.5-3.7 V Violet: 400-450 nm ~ 2.8-4 V

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