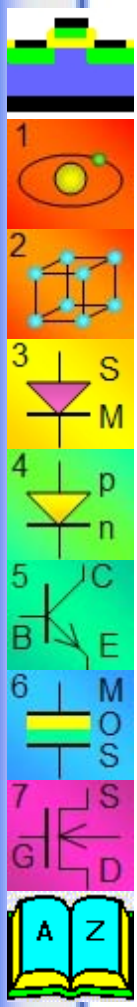
Principles of Semiconductor Devices

Appendix:



Appendix 1: List of Symbols

Symbol	Description	MKS Units
A	Area	m^2
c	Speed of light in vacuum	m/s
C	Capacitance per unit area	F/m^2
C_{FB}	Flatband capacitance per unit area of a MOS structure	F/m^2
C_j	Junction capacitance per unit area	F/m^2
C_{ox}	Oxide capacitance per unit area	F/m^2
D_n	Electron diffusion constant	m^2/s
D_p	Hole diffusion constant	m^2/s
E	Energy	Joule
$\mathcal{E}$	Electric field	V/m
E_a	Acceptor energy	Joule
E_c	Conduction band energy of a semiconductor	Joule
E_d	Donor energy	Joule
E_F	Fermi energy (thermal equilibrium)	Joule
E_g	Energy bandgap of a semiconductor	Joule
E_i	Intrinsic Fermi energy	Joule
E_v	Valence band energy of a semiconductor	Joule
E_{vacuum}	Electron energy in vacumm	Joule
$f(E)$	Distribution function (probability density function)	
F_n	Quasi-Fermi energy of electrons	Joule
F_p	Quasi-Fermi energy of holes	Joule
$g_c(E)$	Density of states in the conduction band per unit energy and per unit volume	$m^{-3}J^{-1}$
$g_v(E)$	Density of states in the valence band per unit energy and per unit volume	$m^{-3}J^{-1}$
G_n	Electron generation rate	$m^{-3}s^{-1}$
G_p	Hole generation rate	$m^{-3}s^{-1}$
h	Plank's constant	Js
$\hbar$	Reduced Plank's (= h /2p)	Js
I	Current	A
J	Current density	A/m^2
J_n	Electron current density	A/m^2
J_p	Hole current density	A/m^2
k	Boltzmann's constant	J/K

l	Mean free path	m
L	Length	m
L_n	Electron diffusion length	m
L_p	Hole diffusion length	m
m	Mass	kg
m_0	Free electron mass	kg
m_e^*	Effective mass of electrons	kg
m_h^*	Effective mass of holes	kg
n	Electron density	m^{-3}
n_i	Intrinsic carrier density	m^{-3}
$n(E)$	Electron density per unit energy and per unit volume	m^{-3}
n_0	Electron density in thermal equilibrium	m^{-3}
n_i	Intrinsic carrier density	m^{-3}
N	Doping density	
N_a	Acceptor doping density	m^{-3}
N_a^-	Ionized acceptor density	m^{-3}
N_B	Base doping density	m^{-3}
N_c	Effective density of states in the conduction band	m^{-3}
N_C	Collector doping density	m^{-3}
N_d	Donor doping density	m^{-3}
N_d^+	Ionized donor density	m^{-3}
N_E	Emitter doping density	m^{-3}
N_v	Effective density of states in the valence band	m^{-3}
p	Hole density	m^{-3}
$p(E)$	Hole density per unit energy	m^{-3}
p_0	Hole density in thermal equilibrium	m^{-3}
p_n	Hole density in an n-type semiconductor	m^{-3}
q	electronic charge	C
Q	Charge	C
Q_d	Charge density per unit area in the depletion layer of an MOS structure	C/m^2
$Q_{d,T}$	Charge density per unit area at threshold in the depletion layer of an MOS structure	C/m^2
Q_i	Interface charge density per unit area	C/m^2
R	Resistance	Ohm
R_n	Electron recombination rate	$m^{-3}s^{-1}$
R_p	Hole recombination rate	$m^{-3}s^{-1}$
t	Thickness	m
t_{ox}	Oxide thickness	m
T	Temperature	Kelvin
U_n	Net recombination rate of electrons	$m^{-3}s^{-1}$
U_p	Net recombination rate of holes	$m^{-3}s^{-1}$
v	Velocity	m/s
v_{th}	Thermal velocity	m/s
V_a	Applied voltage	V
V		

$_B$	Base voltage	V
V_C	Collector voltage	V
V_D	Drain voltage	V
V_E	Emitter voltage	V
V_{FB}	Flatband voltage	V
V_G	Gate voltage	V
V_t	Thermal voltage	V
V_T	Threshold voltage of an MOS structure	V
w	Depletion layer width	m
w_B	Base width	m
w_C	Collector width	m
w_E	Emitter width	m
w_n	Width of an n-type region	m
w_p	Width of a p-type region	m
x	Position	m
x_d	Depletion layer width in an MOS structure	m
$x_{d,T}$	Depletion layer width in an MOS structure at threshold	m
x_j	Junction depth	m
x_n	Depletion layer width in an n-type semiconductor	m
x_p	Depletion layer width in a p-type semiconductor	m
a	Transport factor	
b	Current gain	
g	Body effect parameter	$V^{1/2}$
g_E	Emitter efficiency	
d_n	Excess electron density	m^{-3}
d_p	Excess hole density	m^{-3}
$DQ_{n,B}$	Excess electron charge density in the base	C/m^2
e_{ox}	Dielectric constant of the oxide	F/m
e_S	Dielectric constant of the semiconductor	F/m
m_n	Electron mobility	$m^2/V\text{-}s$
m_p	Hole mobility	$m^2/V\text{-}s$
r	Charge density per unit volume	C/m^3
	Resistivity	Wm
r_{ox}	Charge density per unit volume in the oxide	C/m^3
s	Conductivity	$W^{-1}m^{-1}$
t_n	Electron lifetime	s
t_p	Hole lifetime	s
f	Potential	V
f_B	Barrier height	V
f_F	Bulk potential	V
f_i	Built-in potential of a p-n diode or Schottky diode	V
f_S	Potential at the semiconductor surface	V
F_M	Workfunction of the metal	V
F_{MS}	Workfunction difference between the metal and the semiconductor	V

F_S	Workfunction of the semiconductor	V
c	Electron affinity of the semiconductor	V