Exercise 1

Solution:

a) $Q_1\ in\ saturation, Q_2 \& Q_o\ in\ cutoff$
$v_{B_1} = 0.1 + v_{BE_1} = 0.1 + 0.8 = 0.9\ V$
$\therefore i_1 = i_{B_1} = \frac{5 - v_{B_1}}{4} = \frac{5 - 0.9}{4} = 1.0225\ mA$
All the other currents are zero, since the other two transistors are off.

b) $Q_1\ in\ reverse\ active, Q_2 \& Q_o\ in\ saturation$
$v_{B_o} = 0.8\ V, v_{B_2} = 0.8 + v_{B_o} = 1.6\ V, v_{B_1} = 0.7 + v_{B_2} = 2.3\ V, v_{C_2} = v_{E_2} + v_{CE_2} = v_{B_o} + 0.1 = 0.9\ V$
$i_1 = \frac{5 - 2.3}{4} = 0.675\ mA$
$i_x = i_y = \beta_R \times i_1 = 0.1 \times 0.675 = 0.0675\ mA$
$i_{B_2} = i_{C_1} = i_1 + i_x + i_y = 0.675 + 2 \times 0.0675 = 0.81\ mA$
$i_{E_2} = i_{C_2} + i_{B_2} = \frac{5 - 0.9}{1.6} + 0.81 = 2.5725\ mA$

c)

d)

e) Case (0,0)|(0,1)|(1,0):
For driver Q_1 in saturation, Q_2, Q_o in cutoff.
For load Q_1 in reverse active, Q_2, Q_o in saturation.
KCL at output of driver,
$\frac{5 - V_o}{4} = 4 \times I_L = 4 \times \beta_R \times i_1 = 4 \times 0.1 \times \frac{5 - 2.3}{4} \rightarrow V_o = 3.92\ V$
$\therefore P = (5 - 0.1) \times i_1 + (5 - 3.92) \times \frac{5 - 3.92}{4} = 5.3141\ mW$
Case (1,1):
$I_L = \frac{5 - 0.9}{4} \times \frac{1}{2} = 0.5125$
$P = (5 - 0) \times 0.0675 \times 2 + (5 - 0) \times \left(i_1 + i_{C_2} + i_{C_o}\right) + 4 \times I_L(0.1 - 0) = 23.397\ mW$

Exercise 2

Exercise 3