3.4 (a) The output will have only the positive portions of the sine wave, i.e., the negative portions will be clipped.
Positive peak voltage = 10V Negative peak voltage = 0V
(b) The output will have only the negative portions of the sine wave, i.e., the positive portions will be clipped.
Positive peak voltage = 0V Negative peak voltage = -10V
(c) None of the diodes conduct, and so the output will be a 0V DC signal.
(d) Both of the diodes conduct when the input voltage \( \leq 0 \), and so the output will be the same as in (a).
(e) D1 conducts when the input is positive, and D2 conducts when the input is negative. Thus, the output follows the input.
(f) D1 does not conduct when the input is negative, and so the output is same as in (a).
(g) D1 shorts to ground when the input is positive, and is cut off when the input is negative, and so the output is same as in (b).
(h) The output is always shorted to ground, as D1 conducts when the input is positive, and D2 conducts when the input is negative.
(i) When the input is positive, D1 is cutoff, and the output follows the input. When the input is negative, D1 conducts and the circuit becomes a voltage divider. So the negative peak is \(-10V \times 1 \text{ K}/(1\text{ K}+1\text{ K}) = -5V\)
(j) When the input is positive, D1 conducts and the output follows the input. When the input is negative, D1 is cut off, and the circuit becomes a voltage divider as in (i). The overall output voltage is same as in (i).
(k) When the input is positive, D1 is cut off, and D2 is conducting. The output stays at 1V then. When the input is negative, D1 is conducting and D2 is cut off. The output then is 1V above the input voltage.

3.10 (a) Assume diode is ON. It acts as a short then, and the two 20K resistors appear in parallel, providing an effective resistance of 10K. Therefore, V is given by:
\[
9V \times \frac{10K}{10K+10K} = 4.5V
\]
\[
I = \frac{1}{2} \times \frac{9V-4.5V}{10K} = 0.225mA
\]

3.106 \( n_i^2 = BT^3 e^{-E_G/kT} \)
\[
B = 5.4 \times 10^{31}; \quad E_G = 1.12eV \text{ for silicon}; \quad k = 8.62 \times 10^{-5} \text{eV/K}; \quad T = \text{absolute temperature.}
\]
Fraction of ionized atoms = \( \frac{n_i}{5 \times 10^{22}} \)
3.114 \ V_o = V_T \ln \frac{N_A N_D}{n_i^2} = 0.025V \ln \frac{10^{16} \text{cm}^{-3} \times 10^{16} \text{cm}^{-3}}{5.37 \times 10^{-18}} = \boxed{0.691V}

\ W_{dep} = \sqrt{\frac{2e}{q} \left( \frac{1}{N_A} + \frac{1}{N_D} \right) V_0} = \sqrt{\frac{2 \times 1.04 \times 10^{-12}F/cm^2 \times \left( \frac{1}{10^{16} \text{cm}^3} + \frac{1}{10^{16} \text{cm}^3} \right)}{0.691V}} = \boxed{0.423 \ \mu m}

Distance into N and P regions, \ x_n = x_p = 0.423 \mu m / 2 = \boxed{0.21 \mu m}

\ q_J = qN_Dx_nA = 1.6 \times 10^{-19}C \times 10^{16} \text{cm}^{-3} \times 0.21 \mu m \times 100 \mu m^2 = 33.9 \times 10^{-15} \ C

\ C_J = \frac{q \cdot A}{W_{dep}} = \frac{1.04 \times 10^{-12}F/cm \times 100 \mu m^2}{0.423 \mu m} = \boxed{24.5 \ \text{fF}}

4.2 Drain current is directly proportional to the width of the MOSFET. So, when the width of the MOSFET is made 10 times the current width, the new current will be 10 times what was present before. So, the labels on the Y-axis should be multiplied by 10 (i.e., 0, 1, 2, 3, ... mA).

Constant of proportionality = \frac{1}{0.5 \times 0.2} = \boxed{10 mA/V^2}

For \ V_{OV} = 0.5V, \ r_{DS} = \frac{V_{DS}}{i_D} = \frac{200mV}{1mA} = 200\Omega

For \ V_{OV} = 2V, \ r_{DS} = \frac{V_{DS}}{i_D} = \frac{200mV}{4mA} = 50\Omega

Range is 200\Omega to 50\Omega.

4.5 In the triode region, for small \ v_{DS}, \ i_D = k_n \frac{W}{L} \left( v_{GS} - V_t \right) v_{DS}

\ r_{DS} = \frac{v_{DS}}{i_D} = \frac{k_n}{k_n} \frac{\left( v_{GS} - V_t \right)}{v_{DS}}

For \ r_{DS} = 1 \ K\Omega, \ 1000 \ \Omega = \frac{1}{100 \times 10^{-9} \ \text{cm}^{-3} \times 10^{-12} F/cm^2 \times 1 \ \mu m \times (5-0.8) \ V}

\implies W = \boxed{2.4 \mu m}