(c) The transistor is in the active region when $i_C > 0$ and $v_C < 0.5 V$. Then,

$$v_C < 1kV_C < 0.5$$

$$1kV_C < 0.5 \Rightarrow v_C > 0.5kV_C = 0.5$$

For $i_C = 5mA, V_C > 1k(5.8m) - 0.5 = 4.8 V$

Hence, the minimum value for $V_C$ is 4.8 V.

(b) $i_C = 100M/(118m) = 118mA$

(c) $v_C = -5kV_C + 20 - 1k(i_C + i_E) = -5k((118m) + 20 - 1k(118m + 118m)) = -5.9 + 20 - 1.19 = 12.9 V$

Since $i_C > 0$ and $v_C > 0.2 V$, the active region operation is confirmed.
2. (a) The field due to $V_A$ is opposite to the original $E$, so $E$ in the depletion region is reduced, but still in the original direction.

(b) The current is in the direction shown for $I$ in the figure (forward bias). This means $e'$s move mainly from right to left across the junction, coming from the $n$-type material.

(c) These electrons flow primarily by diffusion. Note that they move in the direction of $E$. For drift current, they would move in the opposite direction since their charge is negative. Reducing the potential diff. across the junction increases the diffusion current and reduces the drift current (since the original potential difference reduced the net current to zero).
(b),(c) The $\bar{E}$ is increased due to the applied voltage. The reverse bias current is in the direction shown. The current is now due primarily to drift. Electrons making up this drift current move from left to right across the junction, from the p material into the n material. The density of such electrons is quite small so the reverse current is small.

($\text{In the p material, } N_e = \frac{n_i^2}{N_A}$)