1. Five capacitors, $C_1 = 10 \mu F$, $C_2 = 5 \mu F$, $C_3 = 15 \mu F$, $C_4 = 12 \mu F$, $C_5 = 18 \mu F$, are connected as in the figure below. An emf device maintains a potential difference $V_{ab} = +10 V$ between $a$ and $b$.

(a) (10 points) Find the equivalent capacitance between $a$ and $b$;
(b) (10 points) Find the potential difference across $C_4$ and $C_5$;
(c) (10 points) Find energy stored on $C_1$;
(d) (5 points) Find the charge stored on $C_2$.

2. In the following circuit,

(a) (10 points) Find the equivalent resistance between $a$ and $f$, $R_{af}$;
(b) (15 points) Find the potential drop between $a$ and $f$, $V_{af}$;
(c) (10 points) Find the current and power dissipated in $7\Omega$ resistor.

3. In the following circuit,

(a) (10 points) Find currents through all three resistors when $S$ is open;
(b) (20 points) Find currents through all three resistors when $S$ is closed;
(c) (10 points) With $S$ being closed, find the potential difference $V_{bd} = V_b - V_d$.

(Hint: if you do not have the answer from Part (b), show how you will find it in terms of unknown currents through three resistors and known emf values).
4. **(Optional for extra points)** Two plates of a parallel-plate capacitor have an overlapping area $S$ and are separated by a small distance $\delta$. Plate A has a charge $Q$ and Plate B has a charge $-Q$. The capacitor is not connected to any emf source.

(a) **(5 points)** Find the force exerted on Plate A by the charge on Plate B;

(b) **(5 points)** Hold Plate B still, move Plate A slowly away from Plate B by a distance $d \gg \delta$ with an external force. Find the work done by the external force, assuming that $d^2 \ll S$;

(c) **(5 points)** Show explicitly that the work done by the external force in Part (b) equals the energy stored in the parallel-plate capacitor now with capacitance $C \approx \varepsilon_0 S / d$, namely, $U = Q^2 / 2C$. 
