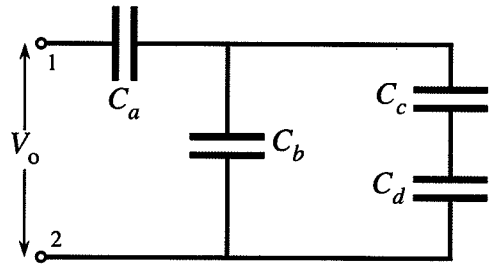
The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

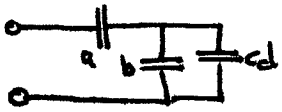
[II] In the capacitor network at right, all capacitors are identical, with capacitance $C = 10\ \mu F$.



#10 (A) *(8 points)* What is the equivalent capacitance of the entire network?

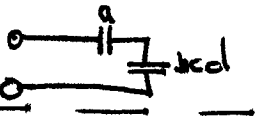
① c and d are in series

$$\frac{1}{C_{cd}} = \frac{1}{C_c} + \frac{1}{C_d} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{cd} = \frac{C}{2}$$



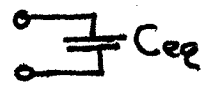
② cd and b in parallel

$$C_{bcd} = C_b + C_{cd} = C + \tfrac{1}{2}C = \tfrac{3}{2}C$$

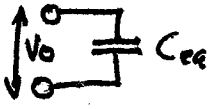


③ a and bcd in series

$$\frac{1}{C_{eq}} = \frac{1}{C_a} + \frac{1}{C_{bcd}} = \frac{1}{C} + \frac{2}{3C} = \frac{5}{3C} \Rightarrow \boxed{C_{eq} = \tfrac{3}{5}C = 6.0\,\mu F}$$

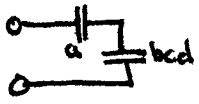


#11 (B) *(8 points)* If the network is held at a potential difference $V_0 = 100$V across terminals 1 and 2, how much electric potential energy will be stored in capacitor *b*?



④ → total charge stored is $Q_{TOT} = C_{eq} V_0 = \frac{3}{5} C V_0$

⑤ a and bcd in series: Same total charge stored: $Q_a = Q_{bcd} = Q_{TOT} = \frac{3}{5} C V_0$



hence, potential across bcd is $\Delta V_{bcd} = \frac{Q_{bcd}}{C_{bcd}} = \frac{3}{5} C V_0 / \frac{3}{2} C$

$$\Rightarrow \Delta V_{bcd} = \frac{2}{5} V_0$$

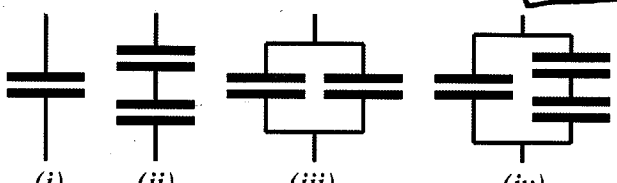
⑥ b and cd in parallel: same potential across each

$$\Delta V_b = \Delta V_{cd} = \Delta V_{bcd} \rightarrow \boxed{\Delta V_b = \tfrac{2}{5} V_0 = 40\text{V}}$$

Thus, stored energy is: $U_b = \frac{1}{2} C_b \Delta V_b^2 = \boxed{8.0\text{mJ}}$

Question value 4 points

(2) In the four networks at right, all capacitors are identical. Rank in order, from least to greatest, the capacitance of each network.



(a) *(ii) < (i) < (iv) < (iii)*

(b) *(iv) < (ii) = (iii) < (i)*

(c) None of the other rankings are correct.

(d) *(i) < (ii) < (iii) < (iv)*

(e) *(iii) < (iv) < (i) < (ii)*

(i) $C_i = C$

(ii) series: $\frac{1}{C_{ii}} = \frac{1}{C} + \frac{1}{C} \rightarrow C_{ii} = \frac{C}{2}$

(iii) parallel: $C_{iii} = C + C = 2C$

(iv) = (i) and (ii) in parallel:

$$C_{iv} = C_i + C_{ii} = \frac{3}{2} C$$