Problem Set 5 Solutions
Due: see website for due dates
Chapter 25: Capacitance
Problems: 4, 13, 14, 19, 29, 41, 45, 48

Question A
An uncharged capacitor is connected to a power supply. (i) How can charge be stored on the capacitor? (ii) How can current flow through a capacitor when its “inners” is an insulator? (iii) If a capacitor is fully charged and disconnected from a power supply, why does it continue to store electrical energy?

Question B
The freshness of fish can be measured by placing a fish between the plates of a capacitor and measuring the capacitance. How does this work?

Question C
A dielectric is pulled from between the plates of a capacitor which remains connected to a battery. What changes occur to the capacitance, charge on the plates, potential difference, energy stored, and electric field?

Question D
Darla charges a parallel plate capacitor with the help of a battery. She then removes the battery and halves the distance between the two plates. (i) What happens to the capacitance and voltage of the capacitor? (ii) Derive and explain why halving the distance between the plates of a disconnected, charged capacitor reduces the stored energy by half?

Problem 25.4
The plates of a spherical capacitor have radii 38.0 mm and 40.0 mm. (a) Calculate the capacitance. (b) What must be the plate area of a parallel-plate capacitor with the same plate separation and capacitance?

Problem 25.13
A 100 pF capacitor is charged to a potential difference of 50 V, and the charging battery is disconnected. The capacitor is then connected in parallel with a second (initially uncharged) capacitor. If the potential difference across the first capacitor drops to 35 V, what is the capacitance of this second capacitor? SSM

Problem 25.14
In the figure, the battery has a potential difference of $V = 10.0$ V and the five capacitors each have a capacitance of $10.0 \, \mu\text{F}$. What is the charge on (a) capacitor 1 and (b) capacitor 2?
Problem 25.19
In the figure, the battery has potential difference $V = 9.0 \text{ V}$, $C_2 = 3.0 \ \mu\text{F}$, $C_4 = 4.0 \ \mu\text{F}$, and all the capacitors are initially uncharged. When switch $S$ is closed, a total charge of $12 \ \mu\text{C}$ passes through point $a$ and a total charge of $8.0 \ \mu\text{C}$ passes through point $b$. What are (a) $C_1$ and (b) $C_3$?

Problem 25.29
What capacitance is required to store an energy of $10 \text{ kW} \cdot \text{h}$ at a potential difference of $1000 \text{ V}$?

Problem 25.41
A coaxial cable used in a transmission line has an inner radius of $0.10 \text{ mm}$ and an outer radius of $0.60 \text{ mm}$. Calculate the capacitance per meter for the cable. Assume that the space between the conductors is filled with polystyrene. SSM

Problem 25.45
A certain parallel-plate capacitor is filled with a dielectric for which $\kappa = 5.5$. The area of each plate is $0.034 \text{ m}^2$, and the plates are separated by $2.0 \text{ mm}$. The capacitor will fail (short out and burn up) if the electric field between the plates exceeds $200 \text{ kN/C}$. What is the maximum energy that can be stored in the capacitor?

Problem 25.48
The figure shows a parallel-plate capacitor with a plate area $A = 5.56 \text{ cm}^2$ and separation $d = 5.56 \text{ mm}$. The left half of the gap is filled with material of dielectric constant $\kappa_1 = 7.00$; the right half is filled with material of dielectric constant $\kappa_2 = 12.0$. What is the capacitance?