7.3 - Capacitance

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- (1998) A girl is holding a metal rod in her hand and rubs its surface with fur. Explain what happens to the rod.
- (1998) Can charge be conserved? Give at least two examples to support your answer.
- (1998) A capacitor of capacitance 3 micro$-F$ is charged until a potential difference of 200 V is developed across its plates. Another capacitor of capacitance 2 micro$-F$ developed a p.d. of 100 V across its plates on being charged.
  - What is the energy stored in each capacitor?
  - The capacitors are then connected by wires of negligible resistance, so that the plates carrying like charges are connected together. What is the total energy stored in the combined capacitors?
  - What would the time constant of the circuit be, if the resistance of each wire connecting the plates was 10Ω ?
- (1999) What is "capacitance"?
- (1999) List three factors that govern the capacitance of a parallel plate capacitor.
- (1999) Show that the energy per unit volume stored in a parallel plate capacitor is given by: $U = 1/2\epsilon E^2$ and define all the symbols in this equation.
- (1999) Given that the distance of separation between the parallel plates of a capacitor is 5 mm, and the plates have an area of 5 m^2 . A potential difference of 10 kV is applied across the capacitor which is
  - parallel in vacuum. Compute:
  - the capacitance
  - the electric intensity in the space between the plates
  - the change in the stored energy if the separation of the plates is increased from 5 mm to 5.5 mm.
- (1999) When an impedance consisting of an inductance L and a resistance R in series is connected across a 12 V, 50 Hz power supply, a current of 0.050 A flows, which differs in phase from that of the applied potential difference by 60° .
  - Find the value of R and L .

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  - Find the capacitance of the capacitor which, when connected in series in the above circuit, has the effect of bringing the current into phase with the applied voltage.

- (1999) (i) Show that the possible energy levels (in Joules) for the hydrogen atom are given by the formula:
  - $E_n = -me^4/(8h^2\epsilon_0^2 * 1/n^2$
  - where m = mass of the electron
  - e = electronic charge
  - h = Planck's constant
  - ϵ_0 = permittivity constant of vacuum
  - What does the negative sign signify in the formula for E , in above?
- (2000) Electrons in a certain television tube are accelerated through a potential difference of 2.0 kV
  - Calculate the velocity acquired by the electrons.
  - If these electrons lose all their energy on impact and given that 10^{12} electrons pass per second in the TV tube, calculate the power dissipated.
- (2000) A coil and a capacitor in parallel are used to make a tuning circuit for a radio receiver. Sketch the resonance curve for the circuit. State two ways of changing the circuit to increase the resonant frequency.
- (2007) What do you understand by an electrostatic generator?
- (2007) The belt of a Van de Graaf generator carries a charge of 100 μC per metre. If the diameter of the lower pulley is 10 cm and its angular velocity is 5 rad/s, what p.d. will the upper conductor attain in 5 minutes if its capacitance to ground is $5x10^{-12}$ F and if there is no leakage of charge?
- (2010) Describe the action of dielectric in a capacitor.
- (2010) A capacitor of 12 μF is connected in series with a resistor of 0.7 MΩ across a 250 V d.c supply. Calculate the current and p.d across the capacitor after 4.2 seconds.
- (2010) Show that the unit of CR (time constant) is seconds and prove that for a discharging capacitor it is the time taken for the charge to fall by 37% .
- (2010) The variable radio capacitor can be charged from 50 pF to 950 pF by turning the dial from 0 degrees to 180 degrees. With the dial at 180 degrees, the capacitor is connected to a 400 V battery. After charging the capacitor is disconnected from the battery and the dial is turned to 0 degrees. What is the charge on the capacitor? What is the p.d across the capacitor when the dial reads 0 degrees and the work done required to turn the dial to 0 degrees? (Neglect frictional effects).
- (2013) Define electric discharge and give one example.
- (2013) An alternating current (a.c) of 0.2 A r.m.s and frequency of $110/2\pi$ Hz flow in a circuit containing a series arrangement of a resistor R of resistance 20Ω , an inductor L of 0.15 H and a capacitor C of capacitance 500 μF . Calculate the potential difference (p.d) and the impedence of the circuit.

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- (2015) What do you understand by dielectric constant?
- (2015) When are the capacitors said to be connected in parallel?
- (2015) The parallel plate capacitor consisting of two metal plates each of area 20 cm^2 placed at 1 cm apart are connected to the terminals of an electrostatic voltmeter. The system is charged to give a reading of 120 V on the voltmeter scale. When the space between the plates is filled with a glass of dielectric constant of 5 , the voltmeter reading falls to 50 V. What is the capacitance of the voltmeter? You may assume that volutage recorded by a voltmeter is directly proportional to the scale reading.
- (2015) A 4.0 μF capacitor is charged by 12 V supply and is then discharged through $1.5M\Omega$ resistor.
  - Obtain the time constant.
  - Calculate the charge on the capacitor at the start of the discharge.
  - What will the value of the charge on the capacitor, the potential difference across the capacitor and the current in the circuit be 2 seconds after the discharge starts?
- (2016) A 25 μF capacitor, a 0.10 H inductor and a 25Ω resistor are connected in series with an a.c. source whose e.m.f. is given by $E = 310\sin(314t)$. Determine the;
  - Frequency of the e.m.f.
  - Net reactance of the circuit.
- (2016) Two capacitors C_1 and C_2 each of area 36 cm^2 separated by 4 cm have capacities of 6 μC and 8 μC respectively. The capacitor C_1 is charged to a potential difference of 110 V whereas the capacitor C_2 is charged to a potential difference of 140 V. The capacitors are now joined with plates of like charges connected together.
  - What will be the loss of energy transferred to heat in the connecting wires?
  - What will be the loss of energy per unit volume transferred to heat in the connecting wires?
- (2016) Define the following terms:
  - Capacitance
  - Charge density
  - Equipotential surface
- (2016) Identify any three factors on which the capacitance of parallel plate capacitor depends.
- (2016) A parallel plate capacitor is made of a paper 40 mm wider and 3.0×10^{-2} mm thick. Determine the length of the paper sheet required to construct a capacitance of 15 μF , if its relative permitting is 2.5 .
- (2016) Show that the possible energy levels (in joules) for the hydrogen atom are given by the formula: $E_n = -k^2(2\pi^2 me^4/h^2)(1/n^2)$. Where m is the mass of electron, e is the electronic charge, h is the Plancks constant, $k = 1/4\pi\epsilon_0$ and ϵ_0 is the permittivity constant of vacuum.
  - What does the negative sign signify in the formula above?

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- (2017) A parallel plate capacitor has plates each of area 0.24 m^2 separated by a small distance
  - 0.50 mm. If the capacitor is full charged by a battery of electromotive force of 24 V, calculate:
  - the capacitance of the capacitor.
  - the energy stared tn the capacitor.
- (2017) Comment on the assertion that, the safest way of protecting yourself from lightning is to be inside a car.
- (2018) A series LCR circuit with inductance, $L = 0.12H$, capacitance, $C = 480$ nF and resistance, $R = 23\Omega$ is connected to a $230V$ variable frequency supply. Determine the:
  - Maximum current flowing in the circuit.
  - Source frequency for which the current is maximum.
- (2018) Briefly explain the effect of the dielectric material on the capacitance of a capacitor when the capacitor is:
  - Isolated.
  - Connected to the battery.
- (2018) How are the electrolytic capacitors made?
- (2019) Elaborate three significance of dielectric material in a capacitor.
- (2019) Give the reason behind a loss of electrical energy when two capacitors are joined either in series or parallel.
- (2019) Why does a room light turn on at once when the switch is closed? Give comment.
- (2019) Outside the sphere, a charged sphere behaves like its charges were concentrated at the centre. If the electric field strength inside the sphere is zero and one sphere of radius 5.0 cm carries a positive charge of 6.7 nC, calculate;
  - the potential at the surface of the sphere.
  - the capacitance of the sphere.
- (2019) What is meant by dielectric constant?
- (2019) A parallel plate capacitor with air as a dielectric has plates of area 4.0×10^{-2} m^2 which are 2.0 mm apart. The capacitor is charged to 100 V battery and connected in parallel with a similar unchanged capacitor with plates of half the area and twice the distance apart. If the edge effect is neglected, calculate the final charge on each plate.
- (2019) Derive an expression for the total capacitance of two capacitors C_1 and C_2 connected in series.
- (2019) Two capacitor of 15 μF and 20 μF are connected in series with a 600 V supply. Calculate the charge and Potential difference across each capacitor.

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