11. (a) i. Write down an expression for the capacitive reactance of a capacitor. [2]

ii. Write down an expression for the inductive reactance of an inductor. [2]

(b) Consider a circuit containing a capacitance C and a generator with EMF $\mathcal{E} = \mathcal{E}_m \sin \omega t$. Derive an expression for the current through the capacitor as a function of time. [6]

(c) Consider a series, lightly damped, undriven RLC circuit.

i. Write an expression for the energy U in terms of the current I through the circuit and the charge Q on the capacitor plates. [3]

ii. Write down the expression for $I(t)$ and $Q(t)$ for the lightly-damped RLC circuit. [3]

iii. Show that $\Delta U/U$, the fraction of the energy lost per cycle of oscillation, is given to a close approximation by

$$\frac{\Delta U}{U} \simeq k\frac{R}{\omega L}$$

and determine the constant k. [4]

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