Solutions for Tutorial: Continuity

Just final answers are given so far. By solving the initial equilibrium, and using continuity to fill the values of capacitor voltages and inductor currents even after a step change in the circuit, a solvable dc circuit should be obtained that will give the requested solution.

1.

a) $i(0^+) = \frac{U}{3R}$

b) $u(0^+) = IR$

c) $u(0^+) = -U$

d) $u(0^+) = \frac{1}{2}IR \qquad i(0^+) = 0$

e) $u(0^+) = IR$

f) $u(0^+) = 0$

2.

At $t = 0^-$:

The switch is open. The circuit is assumed to be in equilibrium, so the usual replacements (capacitors open, inductors shorted) can be made.

Due to the open-circuit capacitor and KCL,

$$i_y(0^-) = Gu_x.$$

To find u_x, take KVL around the complete upper loop:

$$u_x + i_y R_1 + 0 + U + 0 + IR_2 = 0.$$

Putting these together,

$$u_x(0^-) = -\frac{U + IR_2}{1 + GR_1},$$

from which

$$i_y(0^-) = -\frac{U + IR_2}{1 + GR_1}G.$$

At $t = 0^+$:

The switch is closed, short-circuiting the current-source and making the circuit rather simpler.

We replace the capacitor with a voltage source: by continuity,

$$u_x(0^+) = u_x(0^-) = -\frac{U + IR_2}{1 + GR_1}.$$

We replace the inductors by current sources based on the values from $t = 0^-$, with current I passing right to left through L_2, and $I + Gu_x$ downwards through L_1.

KVL around the bottom loop (with the closed switch, R_1, C) shows that

$$i_y(0^+) = -\frac{u_x}{R_1} = \frac{U + IR_2}{R_1(1 + R_1 G)}.$$

(At this point [or earlier?] we realise we didn't actually need to include the inductor currents into the circuit in order to solve the requested values.)