Name:

1. (20 points) We have a power supply v_s which is powering a chip. The power supply nominally generates 5V, but it also has a $1MHz$ ripple. There is a PCB trace (wire) connecting the power supply to the chip which has a small resistance $R_{trace} = 0.1\Omega$. We can model the chip which is drawing power from the resistor as $R_{chip} = 10\Omega$. To reduce the supply ripple, we put a decoupling capacitor next to the chip.

$$v_S(t) = 5(1+0.05sin(10^6t))$$

R$_{trace}$ = 0.1Ω

$v_C(t)$

R$_{chip}$= 10Ω

C = 0.1μF
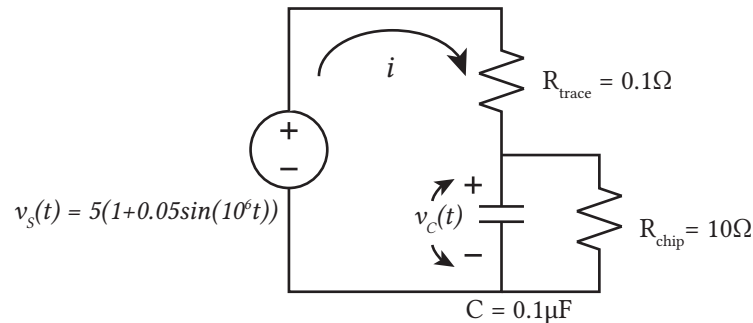
   (a) (5 points) Write Kirchoff's Current law for the ground node in this circuit.

   (b) (10 points) Write Kirchoff's Voltage Law equation for the two loops (one involving the capacitor and the other involving R_{chip}).

   (c) (10 points) Combine the equations from parts a and b into one where the only unknown is v_{chip}.

   (d) (5 points) Put the equation from part c into standard form for an integrating factor $\frac{df}{dt} + Pf(t) = Q$

   (e) (5 points) Write out the integrating factor $I = e^{\int P dt}$

   (f) (5 points) Multiply the equation from part d by the integrating factor.

   (g) (5 points) Solve the differential equation from part (f) for $v_{chip}(t)$:

$$If(t) = \int IQ dt$$

   (h) (5 points) Plot the solution from part (g).