Week 4 Questions and Answer Key

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14. A relay winding has an inductance of 0.5h and a resistance of 470Ω. If the winding current i equals $t^{\frac{1}{2}} + 0.02$ amps, find the voltage vg across the winding when $t = 0.01$ seconds. $vg = 53.9v$

15. A series circuit consists of a 22h inductor and a 68Ω resistor. A current $i = 2t^2 + t$ exists in this combination. After what time t does the voltage across the combination equal 375 volts? $t = 1.784$ seconds

16. A voltage $v = t^3 + 1,000$ volts appears across a parallel RC combination, where $R = 2M\Omega$ and $C = 1\mu F$. Find the resulting current ig at any time t.
$ig = 3 \times 10^{-6}t^2 + 500 \times 10^{-9}t^3 + 500 \times 10^{-6}$

17. A transistor operates into a load resistance of $2.2K\Omega$. The shunt capacitance in the circuit equals $70pf$, as measured at the collector. Over a certain interval the output voltage supplied by the transistor equals $v = 1x10^7t + 30$ volts. Find the collector signal current when $t = 10\mu s$. $ic = 59.791mA$

18. A current $i = 10t^{\frac{1}{2}} + 0.1$ amps flows through a series RL circuit, where $R = 800\Omega$ and $L = 320h$. Find the voltage vg across this circuit when $t = 0.04$ seconds.
$vg = -6.32Kv$

19. A transistor collector has a load resistor of $4.7K\Omega$ with a compensation inductor $L = 20mh$ in series with the resistor. The current i through the combination equals $2.5x10^4t + 0.01$ amps. Find the voltage across the RL circuit when $t = 25ns$.
$vg = -450.063v$

20. A $27K\Omega$ resistor shunts a $33\mu f$ capacitor. The applied voltage v equals $300t^2$ volts. At what time t does the total current i equal $84mA$?
$t = 1.999s$

21. The voltage applied across a capacitor of $0.2\mu f$ was $v = 5 - 3t^2$ volts. The energy stored in a capacitor is $w = \frac{Cv^2}{2}$ joules. Find a formula for $\frac{dw}{dt}$ in this capacitor.
$\frac{dw}{dt} = -1.2 \times 10^{-6}t(5 - 3t^2)$ OR $3.6 \times 10^{-6}t^3 - 6 \times 10^{-6}t$

22. The intensity I of light from a tungsten filament varies with the applied voltage according to $I = Av3.7$, where A is a constant and v is the applied voltage. If $v = t - 2t^2$, find a formula for $\frac{dI}{dt}$.
$\frac{di}{dt} = 3.7a(t - 2t^2)^{2.7}(1 - 4t)$

23. When a length l meters of a conductor moves at a speed of v meters per second in a magnetic field of uniform flux density β teslas, a voltage is induced equal to $v = -\beta lv$ volts. If $v = 10$ meters per second, $l = 0.3$ meter, and β varies over a certain interval according to $\beta = \frac{1}{t^2}$, find $\frac{dv}{dt}$ when $t = 0.5$ seconds.
$\frac{dv}{dt} = 48v/sec$

24. The frequency of a certain crystal oscillator varies with temperature T according to $f = fa[1 + k(T - Ta)]$, where fa is the frequency at an initial temperature Ta and k is a constant of the crystal. If T varies with time (t minutes) according to $T = 55 + 0.01t^2$, how fast does f change when $t = 10$?
$\frac{df}{dt} = fak(0.2)$

25. The wavelength λ meters of a radio wave traveling at a speed $c = 3 \times 10^8$ meters per second varies with the frequency according to $\lambda = \frac{c}{f}$. If $f = 1 \times 10^8 + (5 \times 10^7)t^{\frac{1}{2}}$ hertz find a formula for $\frac{d\lambda}{dt}$.
$\frac{d\lambda}{dt} = \frac{-7.5\times 10^{15}}{(1\times 10^8 + 5\times 10^7 t^{\frac{1}{2}})^2 t^{\frac{1}{2}}}$ seconds

26. The voltage v across a varying resistor r, carrying a fixed current I, is $v = Ir$. If r varies with time t according to $r = t^3 + 5$, find a formula for $\frac{dv}{dt}$ in this capacitor.
$\frac{dv}{dt} = 3t^2 I$

27. The mutual inductance between two windings is $M = \frac{N_2\phi_2}{1_1}$, where i_1 is the current in one of the windings and N_2 and ϕ_2 are the number of turns of the second winding and the flux linking it to the first winding. If i_1 and N_2 are constant, and if the second winding moves so that ϕ_2 varies with time t seconds according to $\phi_2 = t^3 - 2t$, find a formula for $\frac{dm}{dt}$.
$\frac{dm}{dt} = \frac{n_2}{i_1}(3t^2 - 2)$

28. A copper wire of diameter d and length s has a resistance of $r = \frac{ks}{d^2}$, where k is a constant. Suppose a sliding wire changes the length so that $s = t^2 - 0.6t$, where t is in seconds. Find a formula for $\frac{dr}{dt}$.
$\frac{dr}{dt} = \frac{k}{d^2}(2t - 0.6)$

29. The force between two charged particles having fixed charges Q_1 and Q_2 varies with the distance separating them according to $f = \frac{Q_1Q_2}{4\pi\epsilon s^2}$. If ϵ is a constant, and if s varies with time as $s = 6t^{\frac{3}{2}}$, find a formula for $\frac{df}{dt}$.
$\frac{df}{dt} = \frac{-Q_1Q_2}{48\pi\epsilon t^4}$