ENGR 1990 Engineering Mathematics  
Lab/Recitation #12 – Applications of Derivatives II

1. The response of an under-damped, spring-mass-damper system is
   \[ x(t) = e^{-3t} (3\sin(10t) + 2\cos(10t)) \text{ (ft)} \]

   Using the table of derivatives and the rules for differentiation, find
   a) \( v(t) = \dot{x}(t) \) the velocity function
   b) \( x(0), v(0) \) the initial position and velocity of \( m \)
   c) the time \( t^* \) when \( m \) has its maximum downward displacement

2. A voltage \( v(t) = 100e^{-20t} \sin(20\pi t) \) (volts) is applied to a capacitor with \( C = 50 \) (\( \mu \)F). Using the table of derivatives and the rules for differentiation, find the current \( i(t) \) as an exponential function times a single, phase-shifted cosine function. Given:
   \[ i(t) = C \frac{dv}{dt} \]

3. A current \( i(t) = 25t e^{-5t} \) (amps) is applied to an inductor with \( L = 500 \) (mH). Using the table of derivatives and the rules for differentiation, find
   a) the time \( t^* \) when the current is maximum
   b) \( v(t) \) the voltage across the inductor. \[ v(t) = L \frac{di}{dt} \]