You must show and explain your work! The following formulas may, or may not, be useful.

1. (*10 points*)

a. (*2 pts*) Circle all of the following expression which are **linear** differential equations.

(i) $y''' - y'' + y = 0$

(ii) $(y')^3 = y^2$

(iii) $\ln(y') - y = x\cos(x)$

(iv) $e^x y^{(7)} - \left(x^2 - 3\right) y = \sin\left(x^2\right)$

b. (*2 pts*) Circle all of the following expression which are linear **nonhomogeneous** differential equations.

(i) $y''' - y'' = y - x^2\sin(x)$

(ii) $t^2 \dfrac{d^3 f}{dt^3} + t\dfrac{df}{dt} + t^5 = t^5$

(iii) $y^{(3)} - \sec(x)y' - y = e^x$

(iv) $y^{(3)} - x^5 y' - 2x^2 = 0$

c. (*3 pts*) Compute $\mathcal{L}\left\{e^{5t}\sin(3t)\right\}$.

d. (*3 pts*) Compute $\mathcal{L}^{-1}\left\{\frac{9}{s+2} + \frac{3}{s^2+16}\right\}$.

2. (*10 points*) Solve the following differential equations.

a. (*5 pts*) $e^y\,dx + (2y + xe^y)\,dy = 0$

b. (*5 pts*) $y' - \dfrac{3}{x+1}y = (x+1)^4$

3. (*20 points*) Solve the following differential equations. Your answers should be written as real general solutions.

a. (*5 pts*) $y'' - 4y' + 13y = 0$

b. (*5 pts*) $x^2y'' + 5xy' + 4y = 0$

c. (*10 pts*) $y'' - 8y' + 15y = 8\cos(x) - 14\sin(x)$

4. (*10 points*) Use the Laplace Transform to solve the initial value problem $y'' = 2 + 3t$ with initial conditions $y(0) = 0$, $y'(0) = 0$. (You must use the method of Laplace Transform for credit.)