ANSWER KEY

1. 3rd order, linear; 2nd order, nonlinear; 1st order, linear

2. D

3. D

4. C

5. A

6. C

7. D

8. B

9. (a) $y = -4, 0, 2$
   
   (b) $y = -4$ is (asymptotically) stable, $y = 0$ is semistable, and $y = 2$ is unstable.
   
   (c) $\lim_{t \to \infty} y(t) = 0$
   
   (d) $\lim_{t \to \infty} y(t) = -4$

10. (a) $Q' = 30 - \frac{3}{3t + 800} Q$, $Q(0) = 0$

    (b) $P(t) = \frac{4t^2 + 240t + 120}{t + 30}$

11. (a) $\frac{\partial M}{\partial y} = 16x^3y^3 = \frac{\partial N}{\partial x}$

    (b) $x^4y + x^2 - 2y = 4$
12. (a) $y_c = C_1 e^{-5t} + C_2 t e^{-5t}$

(b) $Y = (A t + B) e^{2t} \cos 5t + (C t + D) e^{2t} \sin 5t + E e^{-t}$

(c) $Y = (A t^4 + B t^3 + C t^2) e^{-5t} + D t^2 + E t + F$

13. (a) $u(t) = 2 e^{-2t} \cos 4t + e^{-2t} \sin 4t$

(b) $\mu = 4$ (radians/second)

(c) True (b/c the system is underdamped)