# Chapter 1 Introduction to Differential Equations

#### Section 1.2

- This D.E. is of order two because the highest derivative in the equation is y".
- Order is 1.
- This D.E. is of order one because the highest derivative in the equation is y'. (Note: (y') ≠ y''')
- Order is 3.
- Differentiating gives us y' = ke<sup>kt</sup>. Substitution yields ke<sup>kt</sup> + 2e<sup>kt</sup> = 0. Therefore, k = -2.
- 6.  $y'' y = 0 \Rightarrow k^2 e^{kt} e^{kt} = 0 \Rightarrow k = \pm 1$ .
- 7. Differentiating gives us  $y' = -2k \sin 2te^{t\cos 2t}$ . Substitution yields  $-2k \sin 2te^{t\cos 2t} + \sin 2te^{t\cos 2t} = 0$ . Therefore,  $\sin 2te^{t\cos 2t}(-2k+1) = 0$ , and solving for k gives us  $k = \frac{1}{2}$ .
- 8.  $y = ke^{-t}$ , y' + y = 0,  $-ke^{-t} + ke^{-t} = 0$ , k can be any real number.
- 9 (a).  $y = Ce^{t^2}$ . Differentiating gives us  $y^* = Ce^{t^2} \cdot 2t = 2ty$ . Therefore,  $y^* 2ty = 0$  for any value of C.
- 9 (b). Substituting into the differential equation yields y(I) = Ce<sup>1+</sup> = Ce. Using the initial condition, y(I) = 2 = Ce. Solving for C, we find C = 2e<sup>-1</sup>.
- 10. y''' = 2.  $y'' = 2t + c_1$ ,  $y' = t^2 + c_1t + c_2$ ,  $y = \frac{t^3}{3} + c_1\frac{t^2}{2} + c_2t + c_3$ . Order = 3 3 arbitrary constants
- 11 (a).  $y = C_1 \sin 2t + C_2 \cos 2t$ . Differentiating gives us  $y' = 2C_1 \cos 2t 2C_2 \sin 2t$ and  $y'' = -4C_1 \sin 2t - 4C_2 \cos 2t = -4(C_1 \sin 2t + C_2 \cos 2t) = -4y$ . Therefore, y'' + 4y = -4y + 4y = 0 and thus  $y(t) = C_1 \sin 2t + C_2 \cos 2t$  is a solution of the D.E. y'' + 4y = 0.
- 11 (b).  $y(\frac{\pi}{4}) = C_1(1) + C_2(0) = C_1 = 3$  and  $y'(\frac{\pi}{4}) = 2C_1(0) 2C_2(1) = -2C_2 = -2 \Rightarrow C_2 = 1$ .
- 12.  $y = 2e^{-kx}$ .  $y' + ky = -8e^{-kx} + 2ke^{-kx} = 2(k-4)e^{-kx} = 0$  $\therefore k = 4$ .  $y(0) = 2 = y_0$ .  $\therefore k = 4, y_0 = 2$ .

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