

**ERRATA for FIRST printing of  
Differential Equations & Linear Algebra  
by Farlow, Hall, McDill, & West**  
Updated March, 2004. These were corrected in second printing.

**Please see the errata for second printing for additional errata discovered later.**

## Chapter 1

- p. 25 **1.3 #39-42:** Add to instructions:  
**Plot sample solutions on a direction field and discuss.**
- p.27 **1.3 #55:** Second column, replace  $\ln (...)$  by  $\ln | ... |$ .
- p.34 **1.4 #11:** Replace the entire problem statement with  
**Stefan's Law Again** An interesting analysis results from playing with the equation of Stefan's Law of Radiation (Sec. 1.3, Problem 55) :  
 $dT/dt = k(M^4 - T^4)$ . Suppose  $k = 0.05$ ,  $M = 3$ , and  $T(0) = 4$ .  
(a) Estimate  $T(1)$  by Euler's method with stepsizes  $h = 0.25$ ,  $h = 0.1$ .  
(b) Graph a direction field and both multistep approximations from (a). Explain why and how the approximations from (a) take different routes.  
(c) Find an equilibrium solution; relate it to (a) and (b).
- p.34 **1.4 #13:** Replace *then worsens due to roundoff* with  
*...but will eventually worsen due to roundoff when  $h$  is small enough or calculation coarse enough.*
- p.35 **1.4 #19-22:** Replace entire instructions and footnote with  
**Richardson's Extrapolation** Euler's method gives first-order approximations, but can readily be used to make more accurate higher-order approximations, by a clever extension of our discussion of error. The basic idea starts with equation (7).  
When Euler's method starts at  $t_0$  the accumulated discretization error in the approximation at  $t^* = t_0 + nh$  is bounded by a constant times the step size, as shown in equation (7). Thus at  $t^*$  the true solution can be written  
$$y(t^*) = y_n + Ch + O(h^2), \tag{9}$$
where  $y_n$  is the first-order Euler approximation after  $n$  steps. Now repeat the Euler computations with step size  $h/2$ , so that  $2n$  steps are needed to reach  $t^*$ . Equation (9) becomes  
$$y(t^*) = y_{2n} + Ch/2 + O(h^2), \tag{10}$$
Subtracting (9) from two times (10) eliminates the  $Ch$  term, thus giving a **second-order** approximation  
$$Y_R(t^*) = 2y_{2n} - y_n. \tag{11}$$

This technique of raising the order of an approximation by using both  $y_n$  and the half-step approximation  $y_{2n}$  is called **Richardson's extrapolation**<sup>6</sup>; it can be used with any numerical DE method.

In Problems 19--22, approximate the IVP solution at  $t = 0.2$  by twice applying Richardson's extrapolation: Use  $h = 0.1$ , then  $h/2 = 0.05$  to find  $y_R(0.1)$ ; then use  $y_R(0.1)$  to find  $y_R(0.2)$  in the same manner. Compare with exact solutions when possible.

<sup>6</sup> English scientist and applied mathematician Lewis Fry Richardson (1881--1953) first used the technique in 1927. Its simple approach is both computer efficient and easily extended to provide higher-order approximations. Many variations are popular, particularly for approximating solutions to partial differential equations.

p.44 1.5 #22(c): Move 2 out from under to read  $\frac{2\sqrt{h_0}}{k}$ .

Also add that *the bucket has straight sides*.

## Chapter 2

p.64 2.2 #17: Replace  $t^2$  by  $t^3$ .

p.74 2.3 #30: Change displayed formula to read  $(1/r) \ln(d/(d-rA_0))$ .

p.91 2.5 #14:

- Change the initial population to  $0.2 \times 10^9$ ;
- Change final time from 4 to 10 hours;
- Add to end of problem statement

*To calculate the growth rate, assume that growth is initially exponential rather than logistic.*

p. 91 2.5 #15(b): Add *Compare with case of no hunting*.

2.5 #17 (c): Insert *Assume  $a > 0$* .

p. 93 2.5 #34, 35 Instructions, part (b):

Insert *and sample solutions* after *direction fields*.

p. 97 Following first gray box: Replace first sentence (in parentheses) by

*As with unique solutions to first-order DEs, trajectories may appear to merge, especially at an equilibrium, but they will not cross.*

# Chapter 3

p.117 Correct shading of matrices in first line as shown below.

**Illustration of the Matrix Product:**

$$\begin{bmatrix} \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \end{bmatrix}
 \begin{bmatrix} \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \end{bmatrix}
 =
 \begin{bmatrix} \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \end{bmatrix}$$

$m \times r$                    $r \times n$                    $m \times n$

**EXAMPLE 7** Product Practice

p.134 After blue box, shade pivot columns of matrices as shown below.

In Example 3 we saw

$$[A \mid \mathbf{b}] = \left[ \begin{array}{ccc|c} 1 & 1 & 1 & 3 \\ 2 & -3 & -1 & -8 \\ -1 & 2 & 2 & 3 \end{array} \right]$$

had RREF

$$\left[ \begin{array}{ccc|c} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 1 & -2 \end{array} \right]$$

the pivot columns for both matrices (and all those between in Example 3) are the first three columns, accented by shading.

p.135 Shade pivot columns and highlighted elements as shown below.

(a)  $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$  RREF with 3 pivot columns, as indicated

(b)  $\begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$  RREF with 2 pivot columns, as indicated

(c)  $\begin{bmatrix} 1 & 2 & 0 & 3 & 2 \\ 0 & 0 & 2 & 2 & 2 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$  Rule (ii) violated in (2,3)-position

(d)  $\begin{bmatrix} 1 & 2 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$  Rule (iv) violated in (1,2)-position

(e)  $\begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$  RREF with 2 pivot columns

(f)  $\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 \end{bmatrix}$  Rules (iii) and (iv) violated, row 4

- p.148 Second gray box for **Invertible Matrix Characterization**: Delete *invertible* from first line of text.
- p.152 **3.3 #14**: Remove last line of problem text and replace lines 3 and 4 with  
*... by the following handy formula, if  $ad-bc \neq 0$ . I.e., show that  $AA^{-1}=I$ .*
- 3.3 #15**: After the second equation add the phrase  
*... and solving a system of equations for  $a, b, c$  and  $d$ .*
- p.155 **Example 1**, third equation display below box: Replace straight vertical lines with square brackets for  $M_{11}$ ,  $M_{21}$ ,  $M_{31}$ .
- p.157 **Line 3 from bottom**: All three zeroes should be boldface matrices.
- p.164 **3.4 # 37 (a)**: Last line, first displayed equation, right side is  $I_1$ , not  $I$ .

## Chapter 4

- p.229 **4.3 #40**: Delete minus in exponent and follow equation by *for  $\alpha < 0$* .
- 4.3 Instructions** for #46-52: Replace title by *Effects of Nonconstant Coefficients*.
- In final sentence: Delete *nonautonomous*.
  - Replace *these quantities* by  *$m, b,$  and  $t$* .
- p.229 **4.3 #49**: Replace  $(t^2 - 1)$  by  $(x^2 - 1)$ .
- p.230 Third line above **Example 1**: Replace  $c$  by  $a_0$  so as to read  

$$y_p = d/a_0 \ (a_0 \neq 0) \text{ instead of } y_p = d/c \ (c \neq 0) .$$
- p.233 **Example 5**: Correct last two equation displays (just before **Serpent in Paradise**) by inserting  $e^t$  and brackets to read  
*...giving us*
- $$y_p = e^t - \frac{1}{2}t^2 - \frac{1}{2}t - \frac{3}{4} .$$
- The general solution of (7) by the nonhomogeneous principle is*
- $$y = c_1 e^{2t} + c_2 e^{-t} + e^t - \frac{1}{2}t^2 - \frac{1}{2}t - \frac{3}{4} .$$
- p.239 Line below equation (6): Replace *cosine* by *sine*.
- p.242 **Figure 4.5.4** Caption: Replace *solution* by *envelope*.
- p.246 Gray box, last equation, final denominator: Replace coefficient **2** by **4**, so as to read  $4 m^2$ .
- p.248 **4.5 #15 line 2**: Replace  $\cos 5t$  by  $\cos (5t - \delta)$ .
- 4.5 #15 (d)**: Delete *Carefully outline a way to*, to begin final sentence with *Find...*
- 4.5 #18 line 1**: Replace *20 ohm* by *4 ohm*.

## Chapter 5

- p.271 5.1 #30: Last line of blue box: Replace  $T \circ S(\mathbf{u})$  by  $(T \circ S)(\mathbf{u})$  .
- p. 289 **Figure 5.3.1 (b)**: The matrix multiplication and the figure must both be corrected:
- Replace the vector  $[2, -1]$  by the vector  $[2, -2]$  .
  - Move the tip of the blue vector down from  $[2, -1]$  to  $[2, -2]$  .
- p.303 5.3 #42: Delete  $- \mathbf{I}$  from both matrix expressions.
- p.303 5.3 #44: After *example* insert *of matrices  $\mathbf{A}$  and  $\mathbf{A}^T$*  .
- p.318 5.4 #45 line 3: Replace *(a) and (b)* by *(a), (b) and (c)* .

## Chapter 6

- p.330 Middle of page: Replace *Problem 14* by *Problem 21* .
- p.331 6.1 #17:  $\mathbf{u}(t)$  : Insert minus with second element;  
 $\mathbf{v}(t)$  : Delete minus from second element.
- p.333 6.1 #37: Revise first sentence to read  
*After reviewing Sections 2.6 and 4.1, rewrite the story up to now ...*
- p.341 6.2 #28 (a): Elements of displayed  $\mathbf{v}$  should be  $[1, -2, 1]$  instead of  $[1, 0, 0]$  .

# Chapter 7

- p.376 **7.1 Polar Limit Cycles** (after #34) , first line: Add the words  
*in the xy-phase plane* after *Determine the limit cycles* .  
last line, same paragraph but now top of column two: Add *xy-* to read  
*xy-phase-plane trajectories by hand* .
- p.377 **Computer Lab: Phase Plane Analysis:** Line 2: Replace **42-46** by **42-47** .
- p.380 Last line of footnote: Before *y and  $y_0$*  insert *between* .
- p.387 **7.2 #23** line before (a): Change *using the following steps:* to read  
*as follows. Illustrate each part with a phase portrait.*  
(d) After *... for  $k=0$ .* add *Relate the phase portraits for (b) and (d).*  
**Computer Lab** (after #23), line two: After *first-order system* add *with  $x'=y$*  .
- p.392 Last displayed equation: replace *-0.02* with *0.2* .
- p.394 **7.3 Problems:** Change lines 1-3 to read  
**Changing Views** *For each system in Problems 5-10, (a) Analyze behavior by making an xy phase portrait, plus a tx and/or ty graph associated with a typical trajectory.*
- p.395 **7.3 #23** Insert at beginning of final sentence *Using  $\epsilon = 0.00025$  and  $\delta = 0.2$  , .*
- 7.3 #13** Replace system with
- $$\begin{aligned}x' &= x + y \\y' &= y + z \\z' &= -y + 2z\end{aligned}$$
- p.397 **7.4** Paragraph of text below equation (1) and above Fig 7.4.1:  
Replace *wind velocities and air temperature* with  
*rotation speed and nonlinear temperature distributions within convection cells* .
- p. 400 Reverse the numbering of **Fig 7.4.3** and **7.4.4** . Then all references in text will be correct as printed, which is the order in which they are to be read.
- In the third line of equations (2), replace **5.7** by *r* , to read *-rz* .
  - In the caption of **Figure 7.4.3** (the figure within the main text body, properly numbered), replace the final period by *with  $r = 5.7$*  .

## Chapter 8

- p.414 **8.1 #6:** Replace  $-t^2$  by  $-2t^2$ .
- p.415 **8.1 #13** first column on righthand page:  
First formula: Replace  $L(x)$  with  $L(x_1)$ .  
Third formula: Replace  $L(x_1)$  with  $L(x_2)$ .
- p.424 **8.2 #25** line 2: Insert *multivariable* before *calculus*.
- p.444 **Example 7**, final displayed equations: Replace  $e^{-as}/s$  by  $e^{-as}$  and  $e^{-bs}/s$  by  $e^{-bs}$ .
- p.461 **Figure 8.5.5 (a):** Move *v-nullcline* label to *x*-axis, as in (b).
- p.462 **Figure 8.5.7:** Delete point *K* from figure; delete *(in color)* from caption.
- p.487 **Example 2:** After the 4 displayed equations (a)-(d), at end of first sentence: Replace **0.8** by **0.8 i**.

## Chapter 9

- p.503 **Fig 9.3.13:** Replace upper bound on vertical axis to read not **1**.
- p.505 **9.3 #19** line 2: Replace  $0 \leq r \leq 1$  with  $2 \leq r \leq 3$ .

## Chapter 10

- p.517 **10.1 A Matter of Control**, 5th line: Add  
*For Problems 1-6,  $x(0) = 1$ ; for Problems 4-6 add  $\dot{x}(0) = 0$ .*

## Appendix CN

p.546 Problems CN,

#3(c) : Delete the number 2

#5, second line: Insert minus to read

... numbers  $z = -1 \pm i$  satisfy ...

## Appendix LT

p.551 Middle of page, line 3 of new subsection:

Replace *vectors* by *vector spaces* .

p.555 Switch order of #5 and #6 and correct their numbers accordingly.

## Inside Back Cover

Back end paper (inside back cover)

**Formula 20:** Replace  $(t)$  with  $(t - a)$  .



# Answers – Chapter 1

p.572 **1.3 Answers**

#25: Correct to read  $y = (ke^{2t} - 1)/(ke^{2t} + 1)$  .

p.573 **1.3 Answers**

#31: In both equations, replace  $+ e^{2t}/4$  by  $- e^{2t}/4$  .

Also, in second equation, remove extra minus from first numerator.

#55: Replace the equation with:

**Hint: Use partial fractions and the facts that**

$$\frac{dT}{M^2 - T^2} = \frac{1}{2M} \ln \left| \frac{M+T}{M-T} \right| ;$$
$$\frac{dT}{M^2 + T^2} = \frac{1}{M} \arctan \frac{T}{M} .$$

p.573 **1.4 Answers**

#11:  $T(1) \approx 2.9810$  .

#13: After  $2.593742$  add *while Runge-Kutta gives  $y(1) \approx 7182797$ . The true...*

#19:  $y(0.2) \approx 1.2211$  . Compare with  $e^{0.2} \approx 1.2214$  .

#21:  $y(0.2) \approx 1.2476$  .

p.574 **1.5 Answers**

#19(a): Replace second line with

*Theorem holds, but does not say how large  $R$  can be.*

#19(d): Insert *minus* into numerator of solution.

#27: Correct  $y_1, y_2, y_3$  to read:

$$y_1(t) = t + 1, \quad y_2(t) = -t + 1, \quad y_3(t) = t^2 - t + 1 .$$

p.574 #29: Correct  $y_1, y_2, y_3$  to read:

$$y_1(t) = -t + 1, \quad y_2(t) = t^2 - t + 1, \quad y_3(t) = -(1/3)t^3 + t^2 - t + 1 .$$

## Answers – Chapter 2

### p.576 2.2 Answers

- #43: Correct the answers following *For step size 0.1*, to read  
 $y(1) \approx 9.5944$  by Euler's method,  
 $y(1) \approx 11.4018877$  by Runge-Kutta (correct to four decimal places).  
Third display for  $y(1)$ : drop five digits after  $y \approx 11.20206$ .

### p.576 2.3 Answers

- #3: Replace  $y(1)$  by  $y(1/k)$  .  
#7: Replace 4820 by 4830 .  
#33(a): Replace 1.0833 by 1.0832775 ;  
#33(c): Correct to read  
 $r_{\text{daily}} = (1 + (0.08/365))^{365} - 1 = 0.083287\dots$   
(i.e., 8.3287%) effective annual interest rate.

### p.577 2.4 Answers #7(c): Correct to read $2.5 \ln 4 \approx 3.5$ years .

### p.577 2.5 Answers #3: Correct the stability of the equilibria to read $y = 0$ (stable) and $y = a/b$ (unstable) .

### p.578 2.5 Answers #21(b): Change to read ... $y = 0$ , $L$ , $M$ . For $0 < L < M$ , $0$ and $M$ are stable, $L$ is unstable.

### p.579 2.5 Answers

- #25(b): Replace *moves to the left* by *occurs sooner* .  
#27: In first line, replace *the given* by *many* .  
#29: After the expression for  $z(t)$ , add  $y(t) = 1/(1 + (1/c)e^{-kt})$  .

### p.580 2.5 Answers

- #37: Insert a *minus* before the expression for  $y'$  .  
#39: Insert a  $y$  in the expression for  $y'$ , to read  $r e^{-\beta t} y$  .

### p. 581 2.6 Answers

- #9:  $x_e = (c+f)/d$ ,  $y_e = (a-f)/b$  .  
#11: Delete first minus sign in  $x'$ ; delete first minus sign in  $y'$  .

## Answers – Chapter 3

### p.585 3.2 Answers

#37: In top row of 2nd and 4th vectors, replace  $+5$  by  $-5$ .

#39: Replace (twice)  $u$  by  $t$ .

### p.588 3.6 Answers

#45: Insert *span* before  $\{t^3, \dots\}$ .

#53: Replace  $3$  by  $2$ .

## Answers – Chapter 4

### p.589 4.1 Answers

#25: Phase angle is  $\pi$  radians, not  $\pi/4$  radians.

#35: Replace final answer  $-0.75 \text{ m/sec}$  by  $-1.414 \text{ m/sec}$ .

### p.590 4.2 Answers

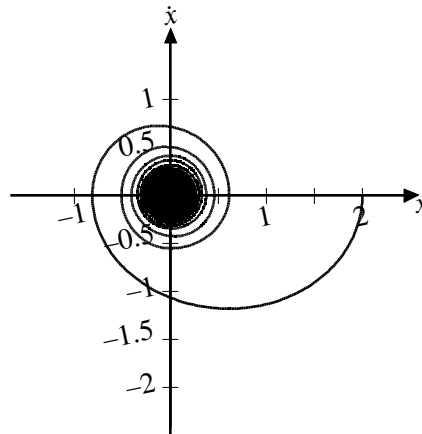
#27: First graph: #1 and #4 are reversed – switch labels.

p.591 #49(c): Final term is  $+50 e^{-10t}$ , not  $-50 e^{-10t}$ .

### p.592 4.3 Answers

#41: Final term needs  $\sqrt{3/3}$ , not  $\sqrt{3/2}$ .

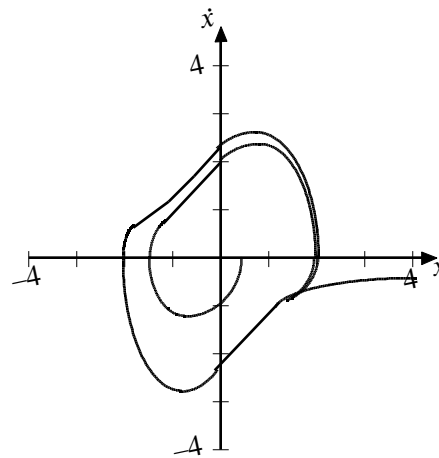
p.593 4.3 Answers #47:



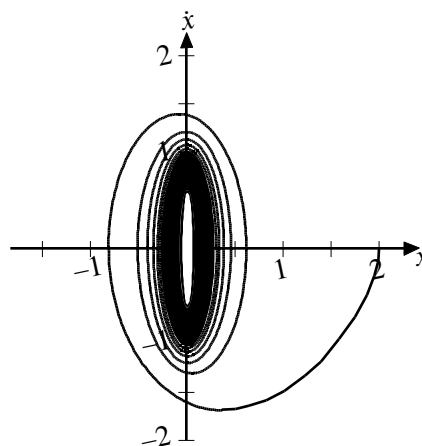
4.3 Answers #49:

Change final sentence to read

*An initial experiment confirms all, but shows unexpected distortion in the cyclic long-term behavior.*



4.3 Answers #51:



p.594 **4.5 Answers**

#13 (e):  $k = 16 \text{ nt/m}$  .

#15 (b):  $b = 4 \text{ nt sec/m}$  .

(e):  $x_{SS} = x_p = \sqrt{2} \cos(5t - \delta)$  .

(f):  $F = 40 \text{ nt}$  .

#17 (c):  $u_{SS}(t) = A t \cos 7t + B t \sin 7t$  or  $C t \cos(7t - \delta)$  .

p.594 **4.6 Answers**

#5: Replace (twice)  $-t$  by  $-2t$  .

p.595 **4.6 Answers**

#29: Replace  $(n-1)$  by  $(n+1)$  .

## Answers – Chapter 5

p. 600 **5.4 Answers**

#41: Replace  $(b)$  by  $(a)$  .

#45: Interchange  $(b)$  and  $(c)$  .

## Answers – Chapter 6

### p. 600 6.1 Answers

#1: Correct picture to be the same as #29.

### p.601 6.1 Answers

#17: In solution for  $\mathbf{x}(t)$ , reverse the signs of the second element in each vector.

### p.602 6.2 Answers

#19: Add to equation to read

$$x(t) = 5e^{2t} \begin{pmatrix} 1 \\ 0 \end{pmatrix} + 4e^{3t} \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 5e^{2t} \\ 4e^{3t} \end{pmatrix} .$$

### p.603 6.3 Answers

#7: In first vector, change *minus* to *plus*.

In second vector, insert *minus* before  $\cos 2t$  .

#15: In vector, first element, change *minus* to *plus*.

### p.604 6.3 Answers

#19: Elements of second vector should be

$$\begin{aligned} & -\cos(\sqrt{3}/2)t + \sqrt{3} \sin(\sqrt{3}/2)t \\ & \cos(\sqrt{3}/2)t + \sqrt{3} \sin(\sqrt{3}/2)t \\ & 2 \cos(\sqrt{3}/2)t \end{aligned}$$

and elements of third vector should be

$$\begin{aligned} & -\sin(\sqrt{3}/2)t - \sqrt{3} \cos(\sqrt{3}/2)t \\ & \sin(\sqrt{3}/2)t - \sqrt{3} \cos(\sqrt{3}/2)t \\ & 2 \sin(\sqrt{3}/2)t \end{aligned}$$

### p.605 6.4 Answers

#13: Second vector in  $\mathbf{w}'$  should be

$$\begin{aligned} & -t^2 + t + 1 \\ & 2t^2 - 2 \\ & t^2 - t - 1 \end{aligned} .$$

and last line of vector for  $\mathbf{x}(t)$  should be

$$c_1 e^{5t} + (c_2 + c_3) e^{3t} - \frac{2}{5} t^2 + \frac{17}{75} t + \frac{1}{1125} .$$

## Answers – Chapter 7

p.608 7.1 Answers

#29: Add *Note that the x axis consists entirely of equilibrium points; both x' and y' are zero.*

p.609 #47 Label x and y axis in graph.

p.610 7.2 Answers

#11: Replace *unstable* by *stable*.

p.611 7.2 Answers

#19: In second line, delete the word *linearized*

#21: In second line, replace  $3y^6$  by  $6y^6$ .

## Answers – Chapter 8

p.614 8.1 Answers

#5: Middle term should be  $4 \cos t$ , not  $4 \cos 2t$ .

p.615 8.1 Answers

#17: First element of third vector should be  $-12$ , not  $-2$ .

8.2 Answers

#19: In last vector, the parenthetical factors should be  $(\ln |t| + 1)$  in the first element, and  $(-\ln |t| - 1)$  in the second.

p.616 8.3 Answers

#65: Correct to read  $y(t) = (2A + B)e^{-t} + (-A - B)e^{-2t}$ .

#71: Replace  $e^{-3t}$  with  $-3e^{-3t}$ .

p.617 8.4 Answers

#69: In first parenthetical expression replace  $+$  by  $-$ .

In second line insert closing paren before  $f()$ .

p.618 8.5 Answers

#11(a): Add to image  $\omega = 1.83$ .

p.619 8.5 Answers

#11(b): Add to image  $\omega = 3.5$ .

## Answers – Chapter 9

### p.621 9.1 Answers

#19(b): Insert minus to read  $y = -0.4348\dots$

#21(b): Insert minus to read  $y = -0.8696\dots$

#23: Insert (a) before the equation as this is the answer only to first part.

### p.624 9.2 Answers

#29(c): Rotate eigenvectors so that blue dots approach them.

### p.625 9.3 Answers

#5b Line 2: Insert  $= 0$  after  $y$ .

### p.629 9.3 Answers

#37(c), top left column: Insert (three orbits) before with.

## Answers – Chapter 10

### p.629 10 Answers

#1: For IVP,  $c=1$  in first line and part (b);  $c = 1/3$  in parts (a) and (c).

#3: For IVP,  $c=1$  in first line and part (b);  $c = 3/5$  in parts (a) and (c).

#5: For IVP, in first line,  $c_1 = 1$ ,  $c_2 = \sqrt{2}/2$ .

(a):  $c_1 = 3/5$ ,  $c_2 = 3/10$ .

(b):  $c_1 = 1/2 + (5/26)\sqrt{13}$ ,  $c_2 = 1/2 - (5/26)\sqrt{13}$ .

(c):  $c_1 = (3/10)(1 + \sqrt{5})$ ,  $c_2 = (3/10)(1 - \sqrt{5})$ .

### p.630 10.1 Answers

#13: Insert 3 before  $e^{-t}$ .

#21: Replace the entire answer as follows, which applies to all three parts:

*HINT: Take the Laplace transform of the control equation and set  $H(s) = U(s)/X(s)$ .*



p.631 10.3 Answers:

#3(c):  $u^*(t) = -1/2$  .

#3(d):  $J(u) = 1/4$  .

#5(b): Change last two lines to read

*we push to the right against the motion of the spring ( $u^* = +1$ )  
and make a soft landing at  $(0,0)$  .*

#7(b): Top of second column: Replace *mass* by *spring* .

## Appendix CN

p.631 Appendix CN Answers

#9:  $z = \cos(2\pi k/m) + i \sin(2\pi k/m) = 1^{1/m}$  .

p.632 Appendix CN Answers

#11(d):  $e^{-\pi i} = \cos(-\pi) + i \sin(-\pi) = -1$  .

## Appendix LT

p.632 Appendix LT Answers

#9: 3rd row, 2nd element is  $2$  , not  $0$  .

#11: 2nd row, 2nd element is  $-3$  , not  $-1$  .

#13: 3rd row, 3rd element is  $0$  , not  $-1$  .