

# MAT 303

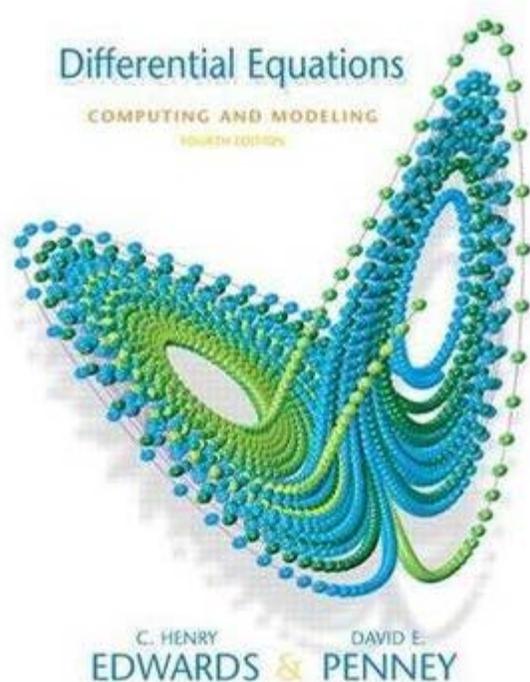
## Calculus IV with Applications

Autumn 2011

This course will introduce basic methods for solving ordinary differential equations, with a particular emphasis on linear differential equations with constant coefficients and systems of differential equations. Differential equations are the language in which the laws of physics are expressed, and have numerous applications in the physical, biological, and social sciences. We will discuss many standard applications. We will also briefly discuss some numerical methods for solving differential equations.

### Textbook:

Differential Equations: Computing and Modeling, 4th Edition, by Edwards & Penney, Pearson/Prentice Hall.



<http://us.mg5.mail.yahoo.com/dc/launch?.gx=1&.rand=35ljst8b7romd>

**Help:** The **Mathematics Learning Centre (MLC)** is located in Math Tower S-240A, and offers free help to any student requesting it. It also provides a locale for students wishing to form study groups. The MLC is open 10am-6pm Monday through Thursday.

The class meets on **Mondays, Wednesdays, and Fridays, 11<sup>45</sup>-12<sup>40</sup>** in **Library-E4330**.

Recitation 01 meets on **Wednesdays, 9<sup>35</sup>-10<sup>30</sup>** in **Light Engineering-152**.

Recitation 02 meets on **Fridays, 1<sup>50</sup>-2<sup>45</sup>** in **Light Engineering-154**.

## Schedule:

Week of	Sections covered Assignment (To be submitted in the right recitation class the week after)	Comments
Aug 28 <sup>th</sup> - Sept 2 <sup>nd</sup>	<b>1.1:</b> 1, 3, 13, 19, 27; <b>1.2:</b> 1, 4, 8, 15, 42; <b>1.3:</b> 2, 8, 21, 29.	
Sept 5 <sup>th</sup> -Sept 9 <sup>th</sup>	<b>1.4:</b> 1, 2, 3, 4, 6, 19, 23, 24, 48; <b>1.5:</b> 1, 2, 3, 5, 12, 15.	No class on Monday 9 <sup>th</sup> , labour day.
Sept 12 <sup>th</sup> - Sept 16 <sup>th</sup>	<b>1.6:</b> 1, 5, 8, 17, 18, 19, 31, 34, 36; <b>2.1:</b> 2, 4, 32, 33.	
Sept 19 <sup>th</sup> - Sept 23 <sup>rd</sup>	<b>2.2:</b> 9, 21; <b>2.3:</b> 2, 4, 6, 25, 26, 29.	
Sept 26 <sup>th</sup> - Sept 30 <sup>th</sup>	<b>2.4:</b> 3, 5; <b>Review</b>	No class on Friday, but Wednesday runs on Friday schedule.
Oct 3 <sup>th</sup> -Oct 7 <sup>th</sup>	<b>3.1:</b> 4, 10, 14, 17, 19, 20, 29, 34, 40, 46.	<b>First midterm exam on Monday, October 3<sup>rd</sup> in class.</b> <a href="#">Answers</a>
Oct 10 <sup>th</sup> -Oct 14 <sup>th</sup>	<b>3.2:</b> 1, 4, 8, 18, 21, 30, 31; <b>3.3:</b> 3, 5, 9, 10, 18, 21, 22.	
Oct 17 <sup>th</sup> -Oct 21 <sup>st</sup>	<b>3.4:</b> 1, 3, 15, 17, 19, 12(a, b, e); <b>3.5:</b> 1, 2, 3, 6, 35, 47, 53.	
Oct 24 <sup>th</sup> -Oct 28 <sup>th</sup>	<b>3.6:</b> 1, 4, 7, 11, 13, 15, 18; <b>3.7:</b> 8, 13, 17.	
Oct 31 <sup>st</sup> - Nov 4 <sup>th</sup>	<b>4.1:</b> 1, 5, 6, 11, 17, 21, 22. <b>Review</b>	
Nov 7 <sup>th</sup> -Nov 11 <sup>th</sup>	<b>5.1:</b> 1, 2, 4, 6, 7, 11, 14, 19, 21, 22, 30; <b>5.2:</b> 1, 6, 11, 19, 41.	<b>Second midterm exam on Monday, Nov. 7<sup>th</sup> in class.</b> <b>Answers</b> The answer to problem 1 must be corrected to $y(x) = c_1 e^{(-1/2x)} + (X) c_2 e^{(-1/2x)}$ , an

		<b>x is missing in the solution.</b>
Nov 14 <sup>th</sup> - Nov 18 <sup>th</sup>	<b>5.4:</b> 1, 3, 11, 15; <b>5.5:</b> 1, 3, 10, 17, 26, 35.	
Nov 21 <sup>st</sup> - Nov 25 <sup>th</sup>	<b>5.6:</b> 1, 2, 8.	No classes on Wednesday or on Friday.
Nov 28 <sup>th</sup> - Dec 2 <sup>nd</sup>	<b>8.1:</b> 1, 4, 6, 14, 18; <b>8.2:</b> 1, 2, 6, 16, 17.	
Dec 5 <sup>th</sup> -Dec 9 <sup>th</sup>	<b>More discussions on power series solutions of ODEs, Review for final exam</b>	
Dec 12 <sup>th</sup> - Dec 16 <sup>th</sup>		Class only on Monday, the last day of classes.  <b>Final exam on Tuesday, Nov. 13<sup>th</sup>, 2:<sup>15</sup>-4:<sup>45</sup>pm.</b>

## Disabilities:

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact Disability Support Services at <http://studentaffairs.stonybrook.edu/dss> or (631)632-6748. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with the lecturer and Disability Support Service. For procedure and information go to the following website: <http://www.stonybrook.edu/ehs/fire/disabilities.shtml>

## Academic integrity:

Each student must pursue their academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at <http://www.stonybrook.edu/uaa/academicjudiciary>

## Teaching Assistants:

**Recitation 01:** Alexandra Popa (Mathematics Building-3-105).

**Office hours:** Tuesday 8-9am in office; Tuesday 10-11am and Thursday 10-11am in the MLC.

**E-mail:** alexandra AT math DOT sunysb DOT edu

**Recitation 02:** S.Ali Aleyasin (Mathematics Building-2-121).

**Office hours:** Tuesday 5-6pm in office; Tuesday and Wednesday 6-7pm in the MLC.

**E-mail:** sali AT math DOT sunysb DOT edu

### **Instructor:**

Prof. C. Denson Hill (Mathematics Building-2-113).

**Office hours:** Monday, Wednesday, Friday 2:30-3:30pm.

**E-mail:** dhill AT math DOT sunysb DOT edu

Name Answers

I.D.# \_\_\_\_\_

1. Solve the initial value problem  $\begin{cases} \frac{dy}{dx} = 3\sqrt{x} \\ y(4) = 0 \end{cases}$ .

$$y(x) = 2x^{3/2} - 16$$

2. Solve the initial value problem  $\begin{cases} \frac{dy}{dx} = 6e^{2x-y} \\ y(0) = 0 \end{cases}$ .

$$y(x) = \ln(3e^{2x} - 2)$$

3. Find the general solution of  $\frac{dy}{dx} + 2xy + 6x = 0$ .

$$y(x) = Ce^{-x^2} - 3$$

4. Find (perhaps implicitly) the general solution to  $(3x^2 + 2y^2)dx + (4xy + 6y^2)dy = 0$ .

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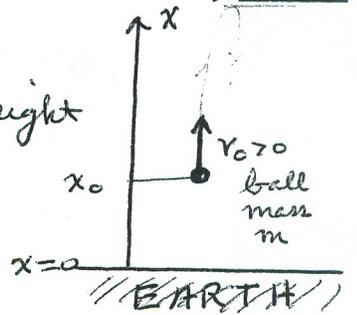
$$x^3 + 2xy^2 + 2y^3 = c$$

5. Find the general solution to  $xy'' + y' = 4x$ .

$$y(x) = x^2 + A \ln x + B$$

6. Assuming you are near the earth, and no air resistance, how high does a ball of mass  $m$  go, if it is thrown upwards with initial velocity  $v_0$  from an initial height  $x_0$  ( $x_0 > 0$  and  $v_0 > 0$ )?

$$x_{max} = x_0 + \frac{v_0^2}{2g}$$



$g =$  gravitational constant

$$x_0 = x(0) > 0$$

$$v_0 = \dot{x}(0) > 0$$

it occurs at time  $\frac{v_0}{g}$

Name Answers I.D.# \_\_\_\_\_1. Find the general solution  $y(x)$  of  $4y'' + 4y' + y = 0$ .

$$y(x) = c_1 e^{-\frac{x}{2}} + c_2 e^{-\frac{x}{2}}$$

2. Solve the initial value problem  $y'' - 3y' + 2y = 0$ ,  $y(0) = 1$ ,  $y'(0) = 0$ .

$$y(x) = 2e^x - e^{2x}$$

3. Find the general solution of  $y'' - 6y' + 13y = 0$ .

$$y(x) = e^{3x} \{c_1 \cos 2x + c_2 \sin 2x\}$$

2  
4.° Use the method of undetermined coefficients to find a particular solution  $y_p(x)$  to  $y'' + 2y' + 5y = e^x \sin x$ .

$$y_p(x) = \frac{1}{65} e^x \{ 7 \sin x - 4 \cos x \}$$

5.° Use variation of parameters to find a particular solution  $y_p(x)$  to  $y'' + 4y = \sin^2 x$ .

Using  $y_1(x) = \cos 2x$ ,  $y_2(x) = \sin 2x$

$$W(x) = 4 = \begin{vmatrix} \cos 2x & \sin 2x \\ -2 \sin 2x & 2 \cos 2x \end{vmatrix}$$

So variation of parameters gives

$$y_p(x) = -\cos 2x \int \frac{\sin^2 x \sin 2x}{4} dx + \sin 2x \int \frac{\sin^2 x \cos 2x}{4} dx$$

Actually

$$y_p(x) = \frac{1}{8} - \frac{x}{8} \sin 2x$$

6. Find the "steady state" periodic solution of  
 $m \ddot{x} + c \dot{x} + kx = F_0 \sin \omega t$ . ( $c > 0$  and  $k > 0$ )

One way of writing the soln is

$$x_p(t) = \frac{F_0}{\sqrt{(k-m\omega^2)^2 + (c\omega)^2}} \sin(\omega t - \alpha)$$

where

$$\tan \alpha = \frac{c\omega}{k-m\omega^2}$$

$$x_p(t) = \frac{-c\omega F_0}{(k-m\omega^2)^2 + (c\omega)^2} \cos \omega t + \frac{(k-m\omega^2) F_0}{(k-m\omega^2)^2 + (c\omega)^2} \sin \omega t,$$

by using undetermined coefficients