

## 課程大綱及進度表

開課系所	數學系
開課學年	100 學年度
開課學期	下學期
課程名稱(中文)	偏微分方程 (一)
課程名稱 (英文)	Partial Differential Equations (I)
課程碼	L170310
分班碼	星期二 7, 8 星期四 1 (3175)
先修科目或先備能力	高等微積分和微分方程
學分數	3
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**課程概述** We study the concepts and basic types of PDE, and their properties. Then we discuss boundary problems, Fourier Series, and Harmonic Functions. Next we investigate the ideas of Green's Identities and Green's Functions, Waves in Space, Boundaries in the Plane and in Space, General Eigenvalue Problems, and Distributions.

**教學目標** We expect to grab the basic idea and concept of PDE. Then we learn various properties of important types of PDE from different aspects.

### 授課課程大綱明細

Ch01: Where PDEs Come From

Ch02: Waves and Diffusions

Ch03: Reflections and Sources

Ch04: Boundary Problems

Ch05: Fourier Series

Ch06: Harmonic Functions

Ch07: Green's Identities and Green's Functions

Ch09. Waves in Space

Ch10. Boundaries in the Plane and in Space

Ch11. General Eigenvalue Problems

Ch12. Distributions and Transforms

Ch13. PDE Problems from Physics

Ch14. Nonlinear PDEs

參考書目 Partial Differential Equations, An Introduction ( Chapter 1 - 12) by Walter Strauss

課程要求 Advanced Calculus and Differential Equations

評量方式 Homework: 30% Midterm : 30% Final: 40%

缺席扣分原則：缺席一堂課扣學期成績一分

課程網址 <http://www.math.ncku.edu.tw/~fang>

助教資訊

備註

Homework, PDE , Spring 2012

Chapter 01:

1.1: 1, 3, 5, 7, 9    1.2: 2, 4, 5, 8, 9    1.3: 1, 3, 5, 7, 9    1.4: 2, 4, 6    1.5: 1, 3    1.6: 2, 4, 6

Chapter 02:    2.1: 1, 3, 5, 7    2.2: 2, 4    2.3: 1, 3, 5    2.4: 2, 4, 6, 8, 10, 12    2.5: 1

Chapter 03:    3.1: 2, 4    3.2: 1, 3, 5, 7, 9    3.3: 2, 3    3.4: 3, 5, 7, 9, 13    3.5: 1

Chapter 04:    4.1: 2, 4, 6    4.2: 1    4.3: 4, 6, 8, 10, 12, 14, 16

Chapter 05:

5.1: 3, 5, 7, 9    5.2: 4, 6, 8, 10, 12    5.3: 3, 5, 7, 9, 11    5.4: 4, 6, 8, 10, 12, 16

5.5: 3, 6, 9, 12    5.6: 2, 5, 8, 11

Chapter 06:    6.1: 2, 5, 8, 11    6.2: 1, 4    6.3: 1, 2    6.4: 2, 5, 8, 11

Chapter 07:    7.1: 2, 5, 8, 11    7.2: 1    7.3: 2    7.4: 3, 6, 9, 12, 15

Chapter 08:    8.1: 1, 3    8.2: 2, 5, 8, 11, 14    8.3: 1, 4, 7    8.4: 2, 5, 8, 11    8.5: 1, 4

Chapter 09:    9.1: 1, 4, 7    9.2: 2, 5, 8, 11, 14    9.3: 3, 6, 9    9.4: 1, 4

Chapter 10:

10.1: 1, 4    10.2: 2, 4, 6    10.3: 3, 6, 9, 12    10.4: 2    10.5: 3, 6, 9, 12, 15    10.6: 2, 5, 8

Chapter 11:    11.1: 1, 3    11.2: 1, 4, 7    11.3: 2    11.4: 1, 3, 5    11.5: 2    11.6: 1, 4, 7

Chapter 12:    12.1: 2, 5, 8    12.2: 1, 4, 7    12.3: 2, 5, 8    12.4: 1, 4    12.5: 2, 5

Chapter 13:

Chapter 14:

**Errata** in "Partial Differential Equations, an Introduction", 1st Edition, by Walter A. Strauss  
(John Wiley and Sons, New York, ISBN 0-471-54868-5)

The Second Edition is now available (ISBN-13 978-0470-05456-7), as well as the Solutions Manual, written jointly with Julie and Steve Levandosky.

The following errata are for the 6th (or later) printing of the First Edition. (To identify which printing your copy is, look at the last number on the page before the preface.) If you have an earlier printing and you wish a list of errata for it, please send me an e-mail message to that effect.

Page

P13, last line:  $ds$  should be  $dx dy$ .

P17-18: The second, third and fourth triple integrals should be over all of  $\mathbb{R}^3$ .

P19, Ex. 8: Assume  $u$  and  $\text{grad}(u)$  tend to zero as  $|x|$  tends to infinity. (This exercise is difficult.)

P42: The bottom line of the page got dropped in the 6th printing! It should be:

$u(x,0)=\phi(x)$ ,  $u(0,t)=g(t)$ ,  $u(\ell,t)=h(t)$ .

P42: In some printings, near the bottom of the page, change  $L$  to  $\ell$ .

P42: Four lines got dropped in the 9th printing! Below equation (2) it should say: .....which is the

"diffusion inequality". Now suppose that  $v(x,t)$  attains its maximum at an interior point  $(x_0, t_0)$ . By ordinary calculus, we know that  $v_t=0$  and  $v_{xx} \leq 0$  at  $(x_0, t_0)$ . This contradicts the diffusion inequality (2). So there can't be an interior maximum. Suppose now.....

P44, line 7: Change min to max.

P49, line 2: Omit the phrase "letting..."

P57, eqn. (8): Change the second  $\geq$  to  $\leq$ .

P58, Ex. 4: Let  $f(x)=x+1-\exp(2x)$  for  $x<0$  [instead of  $x+1$ ].

P60, below eqn.(3): Change  $ct$  to  $c|t|$ .

P64, Ex. 10: Change  $\ell$  to  $\pi/2$ .

P66, midpage: "integral in (5)" should be "integral in (6)". Also, "to formula (3)" should be "to formula (5)".

P70, line -4,-3:  $1+T+T^2$  should be replaced by  $(1+T+T^2)^{-1}$  77, Ex. 7: Change  $n$  to  $m$  in the exponent in the sum. The series converges uniformly for bounded  $t$ . Also  $S''(t)+A^2S(t) = 0$ .

P79, line 13: The integrand should be  $|p| \exp(-p^2/4)$  instead of  $p \exp(-p^2/4)$ .

P94, sentence below eqn. (15): Change "only if  $a_0$  and  $a_\ell$  have opposite signs" to "only if  $a_0$  or  $a_\ell$  is negative or else both vanish".

P98, Ex. 4, line 5: Reverse the sign of the curve.

P98, Ex. 7, line 3: replace  $\lambda$  by  $\beta$  and delete the square, where  $\beta^2=\lambda$ .

P100, line 7: Should be  $x>a$ .

P119, line 8: The sum should start at  $n=0$ .

P123, Example 2: Change  $\ell$  to 1.

P126, eqn.(11):  $4/\pi$ , not  $\pi/4$ .

P127, lines -7,-6: The integrals go from  $a$  to  $b$ .

P127-8: Change  $E_n$  to  $E_N$ .

P129, lines 3,5: Replace  $\ell$  by  $\pi$ . 133: In the proof of (5), change the sign of the second-to-last line.

P136, line -13: Place a factor 2 inside the second square root.

P140, Ex. 12: Assume it satisfies the periodic BC.

P141, end of second paragraph: See Example 3 in Section 5.4 for the dangers of differentiation.

P143, line -3: Switch  $\omega$  and  $c$ .

P149, line 15: Replace "less than" by "less than or equal to".

P153, line 3:  $(r, \theta, \phi)$

P153, eqn.(7): Delete  $u$ .

P158, Ex. 5: Take  $b=1$  for simplicity.

P162, line -1: The last  $u(x)$  should be  $x$ .

P164, Ex. 3:  $\sin^3 \theta$  and  $\sin(3 \theta)$  should be switched.

P165, two lines above (5): Replace  $n$  by  $n \pi$ .

P168, Ex. 12: The domain should be assumed to be connected.

P176, below eqn.(G2): Change  $(G2)$  to  $(G1)$ .

P178, eqn. (5): The left side should be  $u(x_0)$ .

P180, line -9: (7.2.1)

P187, Ex. 7(d): Change  $h(y)$  to  $h(x)$ .

P188, Ex. 18: octant

P188, Ex. 19: Change  $r^{-3/2}$  to  $r^{-2}$ .

P188, Ex. 25: Delete this exercise.

P190, line -5: change the third + to -.

P194, line below (3): A factor of 4 is missing.

P199, Ex. 3: Change  $0 < x < 1$  to  $0 < x < 5$ .

P207, Ex. 2(a): Replace 2 by 0.5.

P207, Ex. 8: Do it for the equation  $u_{tt} = u_{xx} - u^3$ .

P207, line -1: The - should be +.

P222, Ex. 6: Take the boundary conditions to be homogeneous.

P240, Ex. 1, Hint: Exercise 2.4.10 is an alternative hint.

P240, Ex. 5: up to a constant factor.

P248, line -5: In the last term move the bar to the other v.

P251, Ex. 4: Change Robin BC to  $dv/dy = -v$ . In (b) change - to +.

P251, Ex. 5(b): Put a minus in front of the operator.

P254, (18): The coefficients are not correct: see the second edition.

P251, Ex. 5(d): Change Dirichlet to Neumann.

P252, line below (9): Change n to lambda.

P258, line below (4): Change (1) to (2).

P262, table: In the third line, the last -1 should be -r<sup>2</sup>.  
In the fifth line,  $\cos(2\theta)$  should be  $\cos(2\phi)$ .

P267, Ex. 2, Hint: The last two factors should be replaced by  $3 - 2\sin 2x - 2\sin 2y$ .

P270, eqn. (10): Change the second + to -.

P271, eqn. (12): Take the square root of  $2/\pi$ .

P272, eqn. (18): Change  $1/\pi$  to  $2/\pi$ .

P280, two lines above (11): Change  $1/r$  to  $-1/r$ .

P290, line 14: Change 27.3 to 30.5.

P290, formulas for A and B: factors of  $2\pi$  are missing.

P290, above eqn. (6): Assume the trial functions are linearly independent.

P292, Ex. 4:  $a=1$ .

P295, eqn. (4): Change j to n.

P295, eqn. (6) and above: The subscripts should be  $N+1$ .

P297, Ex. 3: Delete the boundary integral. Replace the constraint  $\int w^2 dx = 1$  by  $w=g$  on  $\text{bdy}(D)$ .

P308, Theorem 4: each Dirichlet eigenvalue.

P309: Delete the second paragraph.

P312, Ex. 2 and 3: These exercises are difficult.

P312, Ex. 5: ellipse

P312, Ex. 9(b): On the third line replace D by  $D^+$  in two places.

P322, line -10: Change  $(1/2)c$  to  $1/(2c)$ .

P322-3, eqns. (9),(10): We have permitted any t, positive or negative, in these formulas.?

P327, table: In the last entry, a is positive.

P342, line 1: Change the signs in the equation. ...the inhomogeneous Maxwell equations.

P348, line below (11): The function R is related to Bessel's equation by  $R(kr) = H_0(kr)/\sqrt{kr}$ .

P348-350: Replace  $H^+$  by  $H^-$  throughout.

P348-9, eqn. (12) and eqn. below (17): Divide  $H(kr)$  by  $\sqrt{kR}$ .

P350: Replace the first  $R$  by  $r$ .

P353, Ex. 2: The second term is  $q \psi$ , not  $\psi$ . Assume  $Q > 0$ .

P364, eqn. (12) and line -1: Several terms are missing their integral signs {line integrals over the curve  $x = x_i(t)$ }.

P372, line -1: Change 3 to 1.

P373, Ex. 2: Change + to -.

P374, Ex. 12: There is a missing factor of  $kt^{-1/3}$ .

P378, Ex. 10: Change - to +.

P391, line -1: Change the last  $\cos \phi$  to  $\cos \theta$ .

P394, lines 7 and 19: Change (1) to (2).

In the following pages, there are a few additional errors in the answers and hints. See the second edition for all the corrections.

P401, Ex. 1.4.4: Reverse the sign.

P401, Ex. 1.6.5:  $\beta = -4$  and  $\gamma = 1/\sqrt{3}$ .

P402, Ex. 2.2.5: Put  $\rho$  in the integrand.

P403, Ex. 3.2.9(a): Change  $11/81$  to  $4/27$ .

P404, Ex. 4.3.12, line 3: Delete the 2 in the argument of the cosine.

P404, Ex. 4.3.18(e): Delete the last sentence.

P406, Ex. 5.6.9: Change the last + to -.

P406, Ex. 7.1.10: Change 2 to  $1/2$ .

P407, Ex. 7.4.1: Divide the given answer by  $\ell$ .

P410, Ex. 10.1.2: Change 16 to 64.

P410, Ex. 10.2.5: In the exponent,  $\beta$  should be squared.

P410, Ex. 10.3.6: 193.9 seconds

P410, Ex. 10.3.7:  $3a^2/10$  instead of  $3/10$ .

P410, Ex. 10.5.15: superscripts + on  $H$ .

P411, Ex. 10.6.7: Replace  $A-B$  by  $(A-B)/2$ . Also replace  $!!$  by  $(\ell-2)!!$  in the numerator.

P412, Ex. 11.4.4: Replace  $-\text{sech}$  by  $2 \text{ sech}$ .

P412, Ex. 12.4.1: Replace  $k$  by  $\kappa$ .

(Errata updated as of January 2008)

I take this opportunity to thank all the people who have notified me of errors in the text since its publication. See the Second Edition for specific acknowledgements. (Hopefully I have not forgotten to mention anyone.)