Higher School of Economics 2018

Утверждена Академическим советом
образовательной программы
«5» сентября 2018 г., № протокола_1

Академический руководитель
образовательной программы

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Mathematics for Economics and Business

Part 1: Course Information

Instructor Information

Instructor: Ivan Deseatnicov
Office: To be announced
Office Hours: To be announced
E-mail: To be announced

Course Description

The course consists of three parts. In the first, we introduce some concepts from linear algebra. The second part is devoted to multivariate calculus constrained static optimization. The last section provides an introduction to differential equations and dynamic systems.

This course covers the basic mathematical tools that are used in classical and modern economics analysis and econometrics. By the end of this course, students are expected to master a number of derivations techniques, and this mastering comes only at the price of doing a sizable number of exercise. The instructor is there to help you through the learning process.

Prerequisites

Familiarity with basic algebra and calculus is assumed.

Learning Outcomes

At the completion of this course students are expected to be able to:

- To solve a quadratic equation

- To get familiar with basic functions like logarithm, exponential and power functions and their properties
- To calculate derivatives and integrals involving functions that are often used in economic analysis
- To understand the concepts of convex and concave sets and the relationship with convex and concave functions
- To understand the basic rules for solving constrained or unconstrained optimization problem
- To understand the basic elements of linear algebra, e.g. singularity and non-singularity of a matrix determinant and inverse of a matrix

Textbook & Course Materials

PRESCRIBED TEXTS

Alpha C. Chiang, *Fundamental Methods of Mathematical Economics*, McGraw-Hill, 4th Edition, 2004.

REFERENES (SUGGESTED TEXTS)

Knut Sydsater and Peter Hammond, *Essential Mathematics for Economic Analysis*, Prentice Hall

Teaching & Learning Strategies

Lectures	Lectures provide a weekly direction and structure to the subject. They highlight the more important issues in the textbook, and provide both supplementary and reinforcement material as appropriate. The purpose of the lecture is not to summarize the book but to illustrate key ideas and concepts. We will also solve problems during the lectures time to develop problem solving skills and especially develop students' abilities to apply the relevant theory and equations. **In order to benefits from the lectures you are expected to read the relevant readings and chapters in the textbook before coming to class.** **You are also expected to work through the problems that will be assigned to you after each class.**
Computer Laboratory	N/A
TIMETABLED STUDY	14*2*2 hour Lectures (two lectures per week*14week excluding midterm and final exam weeks) 2*2 hour Midterm & Final Exams
INDEPENDENT	4-8 hours per week

STUDY	
TOTAL EXPECTED STUDY LOAD	8-12 hours per week

Content

The content is structured into 14 weekly lecture and 4 tutorial sessions covering the following topics:

- Equilibrium Analysis
- Linear Models and Matrix Algebra
- Differentiation
- Comparative Statics of General Function Models
- Optimization and Equilibrium
- Exponential and Logarithmic Functions
- Multi-Variable Optimization
- Optimization with Equality Constraints
- Non-Linear Programming and Kuhn-Tucker Conditions
- Duality and Envelop Theorem

LECTURE/SEMINAR/HOMEWORK HOURS

NO	Topic	Contact hours			Home work	Hours total
		Lectures	Seminars	Total		
1	Introduction	4		4	6	6
2	Equlibrium Analysis	4		4	6	6
3	Linear Models and Matrix Algebra	4		4	6	6
4	Linear Models and Matrix Algebra (continued)	4		4	6	6
5	Differentiation and Comparative Statics	4		4	6	6
6	Differentiation and Comparative Statics (continued)	4		4	6	6
7	Comparative Statics of General Function Models	4		4	6	6
Consultation				2	2	4
	Mid-term exam	**4**		**4**		**4**
8	Opimization and Equlibrium	4		4	6	6
9	Exponential and Logarithmic Functions	4		4	6	6
10	Multi variable optimization	4		4	6	6
11	Optimization with Equality Constraints	4		4	6	6

12	Non-Linear Programming and Kuhn-Tucker conditions	4		4	6	6
13	Duality and the Envelope Theorem	4		4	6	6
14	Q&A	4		4	6	6
Consultation				2		4
15	**Final Exam**	**4**		**4**		**4**
	Total	**60**		**60**	**92**	**152**

ASSESSMENT

ASSESSMENT TASK 1	**WEIGHT**	**OUTCOMES**	**DUE**
Problem Set 1 This is intended as an opportunity for revision of the material early in the course.	5%	1, 6	Submission is due in Week 3 (at the end of Week 3)
Further Information This assessment will include 30 multiple choice questions and 1 short answer question. It will cover the topics covered in week 1, 2 and 3 (Ch. 1, 2, 3, 4 & 5). Feedback will be provided in our week 4 class.			

ASSESSMENT TASK 2	**WEIGHT**	**OUTCOMES**	**DUE**
Problem Set 2 This is intended as an opportunity for revision of the material early in the course.	5%	1, 3, 4, 6	Submission is due in Week 7 (at the end of Week 7)
Further Information This assessment will include 30 multiple choice questions and 1 short answer question. It will cover the topics covered in week 3, 4, 5 and 6 (Ch. 6, 7, 8 and 9). Feedback will be provided in our week 8 class. **Both first and second tutorial classes should be done before taking the midterm exam.**			

ASSESSMENT TASK 3	**WEIGHT**	**OUTCOMES**	**DUE**
Midterm Exam Will cover lecture material from week 1 to week 7	30%	1, 3, 4, 6	Midterm Exam period (Week 8)
Further Information The format will be 10 big short essay questions. You are able to use a calculator to solve the questions. **No material allowed for the exam.**			

ASSESSMENT TASK 4	**WEIGHT**	**OUTCOMES**	**DUE**
Problem Set 3	5%	1, 2, 3, 4, and 6	Submission is due in Week 11

This is intended as an opportunity for revision of the material early in the course.			(at the end of Week 11)
Further Information This assessment will include several relevant questions from the textbook used. It will cover the topics covered in week 9, 10 and 11 (Ch. 9, 10 and 11). Feedback will be provided in our week 12 class.			

ASSESSMENT TASK 5	**WEIGHT**	**OUTCOMES**	**DUE**
Problem Set 4 This is intended as an opportunity for revision of the material early in the course.	5%	1, 2, 3, 4, 5 and 6	Submission is due in Week 15 (at the end of Week 15)
Further Information This assessment will include several relevant questions from the textbook used. It will cover the topics covered in week 12, 13, 14 and 15 (Ch. 12, 13 and 14 (if time permits)). Feedback will be provided in our week 16 class before the final exam. **Both third and fourth tutorial classes should be done before taking the final exam.**			

Midterm Exam	**30%**
Final Exam	**40%**
Assignments	**20%**
Attendance	**10%**

Part 2: Grading Policy

The grade for this course is based on a midterm 30%, a final exam 40%, assignments 20%, and attendance 10%

Attendance at lectures and tutorials is essential in this course. To pass the course (an F grade indicates failure), you must submit acceptable work for each item of assessment; and obtain a minimum of 50% in the overall assessments. Students who miss a class more than eight times will directly get an F grade.

Exams

We will have a midterm exam in Week 8 and a final exam in Week 16.

ASSIGNMENTS

I am going to give 4 assignments which will add to a total of 20 percent of the final grade (5 % each). These will be due. You are allowed to work in groups on the assignments but everyone has to submit his or her own copy. Each problem set will be posted on school web board a week before it is due. In fairness to students who complete assignments on time, late assignments will be given 0 credit but will be graded, nevertheless.
Makeup exams will be only given if absence is due to medical reasons (Doctors certificate required).

Part 3: Topic Outline/Schedule

Lecture Outlines:

Week 1

Topics

Introduction of the course

- Ch1. The Nature of Mathematical Economics
  - ✓ Mathematical Versus Nonmathematical Economics
  - ✓ Advantages of the Mathematical Approaches
- Ch2. Economic Models
  - ✓ Types of Models (Visual Models, Mathematical Models, Empirical Models and Simulation Models)
  - ✓ Static and Dynamic Models
  - ✓ Why Comparative Static Models are Usually Used?

Week 2

Topics

- Ch3. Equilibrium Analysis in Economics
  - ✓ The Meaning of Equilibrium
  - ✓ Partial Market Equilibrium-A Linear Model Versus A Nonlinear Model
  - ✓ General Market Equilibrium

Week 3

Topics

- Ch4. Linear Models and Matrix Algebra
  - ✓ Matrix and Vectors
  - ✓ Matrix Operations
  - ✓ Linear Dependence of Vectors
  - ✓ Commutative, Associative, and Distributive Laws

- ✓ Identity Matrices and Null Matrices
- ✓ Transposes and Inverses

- Ch5. Linear Models and Matrix Algebra (Continued)
  - ✓ Conditions for Nonsingularity of a Matrix
  - ✓ Test of Nonsingularity by Use of Determinant
  - ✓ Basic Properties of Determinants
  - ✓ Finding the Inverse Matrix
  - ✓ Cramer's Rule

Problem Set #1: Chapters 1, 2, 3, 4 and 5 (5%)

Week 4

Topics

- Ch6. Comparative Statics and the Concept of Derivative
  - ✓ The Nature of Comparative Statics
  - ✓ Rate of Change and the Derivative
  - ✓ The Derivative and the Slope of a Curve
  - ✓ The Concept of Limit
  - ✓ Inequalities and Absolute Values
  - ✓ Limit Theorems
  - ✓ Continuity and Differentiability of a Function
- Tutorial Revision #1

Week 5

Topics

- Ch7. Rules of Differentiation and Their Use in Comparative Statics
  - ✓ Rules of Differentiation for a Function of One Variable
  - ✓ Rules of Differentiation Involving Two or More Functions of the Same Variable
  - ✓ Rules of Differentiation Involving Functions of Different Variables
  - ✓ Partial Differentiation
  - ✓ Applications to Comparative Static Analysis
  - ✓ Note on Jacobian Determinants

Week 6

Topics

- Ch8. Comparative-Static Analysis of General-Function Models
  - ✓ Differentials
  - ✓ Total Differentials
  - ✓ Rules of Differentials
  - ✓ Total Derivatives
  - ✓ Derivatives of Implicit Functions
  - ✓ Comparative Statics of General Function Models

Week 7

Topics

- Ch9. Optimization: A Special Variety of Equilibrium Analysis
  - ✓ Optimal Values and Extreme Values

- ✓ Relative Maximum and Minimum: First-Derivative Test
- ✓ Second and Higher Derivatives
- ✓ Second-Derivative Test
- ✓ Taylor Series
- ✓ Nth-Derivative Test

Problem Set #2: Chapters 6, 7, 8 and 9 (5%)

Week 8

- Tutorial Revision #2
- Mid-term Exam

Week 9

Topics

- Ch9. Optimization: A Special Variety of Equilibrium Analysis (Continued)
  - ✓ Optimal Values and Extreme Values
  - ✓ Relative Maximum and Minimum: First-Derivative Test
  - ✓ Second and Higher Derivatives
  - ✓ Second-Derivative Test
  - ✓ Taylor Series
  - ✓ Nth-Derivative Test

Week 10

Topics

- Ch10. Exponential and Logarithmic Functions
  - ✓ The Nature of Exponential Functions
  - ✓ Logarithmic Functions
  - ✓ Derivatives of Exponential and Logarithmic Functions

Week 11

Topics

- Ch11. The Case of More Than One Choice Variable
  - ✓ The Differential Version of Optimization Condition
  - ✓ Extreme Values of a Function of Two Variables
  - ✓ Quadratic Forms
  - ✓ Objective Functions with More than Two Variables
  - ✓ Second-Order Conditions in Relation to Concavity and Convexity

Problem Set #3: Chapters 9, 10 and 11 (5%)

Week 12

Topics

- Ch12. Optimization with Equality Constraints
  - ✓ Effects of a Constraint
  - ✓ Finding the Stationary Values
  - ✓ Second-Order Condition
  - ✓ Quasiconcavity and Quasiconvexity
  - ✓ Utility Maximization and Consumer Demand

- Ch13. Further Topics in Optimization
  - ✓ Nonlinear Programming and Kuhn-Tucker Condition
  - ✓ The Constraint Qualification
  - ✓ Maximum-value Functions and the Envelope Theorem
  - ✓ Duality and the Envelope Theorem
- Tutorial Revision #3

Week 13

Topics

- Ch13. Further Topics in Optimization (Continued)
  - ✓ Nonlinear Programming and Kuhn-Tucker Condition
  - ✓ The Constraint Qualification
  - ✓ Maximum-value Functions and the Envelope Theorem
  - ✓ Duality and the Envelope Theorem

Week 14

Topics

- Ch14. Economic Dynamics and Integral Calculus
  - ✓ Dynamics and Integration
  - ✓ Indefinite Integrals
  - ✓ Definite Integrals

Week 15

Topics

- Ch14. Economic Dynamics and Integral Calculus (Continued)
  - ✓ Dynamics and Integration
  - ✓ Indefinite Integrals
  - ✓ Definite Integrals

Problem Set #4: Chapters 12, 13 and 14

Week 16

Topics

- Tutorial Revision #4
- Final Exam

(If time is not enough to go over the full scheduled chapters, it is okay to stop teaching up to chapter 12 or chapter 13)

EXAMINATION PERIOD: See the Midterm and Final Examination timetable on the student intranet for the exact date, time and location of any examinations.

EXAMPLES OF EXAM

1) MIDTERM EXAM

Mathematics for Economics and Business Midterm Exam

Fall 2018

Grades will not be given to students who have cheated or helped anyone else cheat on this exam.

_____
Student ID

Name:_____
DO NOT WRITE YOUR NAME ANYWHERE ELSE ON THIS TEST.

NOTE: I GIVE LOTS OF PARTIAL CREDIT ON TESTS. In mathematics for economics and business tests, if you get an earlier part of a problem wrong, you can get most points on later sections of that problem as long as you are consistent; or if you explain exactly the steps you would do to answer the question.

1. (10 points) A liberal arts college has 1000 students. The numbers studying various languages are: English (E) 420; Korean (K) 316; Chinese (C) 160. These figures include 116 who study English and Korean, 100 who study English and Chinese, 30 who study Korean and Chinese. Finally, all these figures include 16 students taking all three languages.

a. (3 points) How many study English and Korean, but not Chinese?

b. (3 points) How many study Chinese, but neither English nor Korean?

c. (4 points) How many are studying no languages?

2. (8 points) If $f(x) = x^2 + 2x$, compute the following limits:

a. (4 points) $\lim_{x\to 1} \frac{f(x)-f(1)}{x-1}$

b. (4 points) $\lim_{h\to 0} \frac{f(a+h)-f(a)}{h}$

3. (8 points) Evaluate the limits:

a. (4 points) $\lim_{x\to -1} \frac{4-\sqrt{x+17}}{2x+2}$

b. (4 points) $\lim_{x\to 2} \frac{3x^2+3x-18}{x-2}$

4. (16 points) Find the rational roots, if any, of the following:

1) (4 points) $x^3 + \frac{3}{4}x^2 - \frac{3}{8}x - \frac{1}{8} = 0$

2) (4 points) $x^3 - 4x^2 + x + 6 = 0$

3) (4 points) $x^3 - 2x^2 + 3x - 2 = 0$

4) (4 points) $x^3 - x^2 - 4x + 4 = 0$

5. (5 points) Perform the following matrix multiplications to obtain AB where possible:

1) (3 points)

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \quad B = \begin{bmatrix} 4 & 3 \\ 1 & 1 \\ 0 & 2 \end{bmatrix}$$

2) (3 points)

$$A = \begin{bmatrix} 4 & 3 \\ 1 & 1 \\ 0 & 2 \end{bmatrix}, \quad B = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

6. (11 points) Compute the determinants of the following matrices:

1) (3 points)

$$A = \begin{bmatrix} 3 & 0 & 4 \\ 2 & 3 & 2 \\ 0 & 5 & -1 \end{bmatrix}$$

2) (3 points)

$$B = \begin{bmatrix} 2 & -4 & 3 \\ 3 & 1 & 2 \\ 1 & 4 & -1 \end{bmatrix}$$

3) (5 points)

$$C = \begin{bmatrix} 1 & 2 & 1 & 0 \\ 0 & 3 & 1 & 1 \\ -1 & 0 & 3 & 1 \\ 3 & 1 & 2 & 0 \end{bmatrix}$$

7. (12 points) Obtain the inverses of the following matrices by the cofactor method:

1) (4 points)

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}$$

2) (4 points)

$$B = \begin{bmatrix} 1 & 2 & -1 \\ 0 & 1 & 0 \\ -5 & 2 & 3 \end{bmatrix}$$

3) (4 points)

$$C = \begin{bmatrix} 3 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

8. (10 points) Use Cramer's rule to compute the solution of the following system:

1) (5 points)

$$2x_1 + 3x_2 + x_3 = 2$$
$$-x_1 + 2x_2 + 3x_3 = -1$$
$$-3x_1 - 3x_2 + x_3 = 0$$

2) (5 points)

$x_1 + 3x_2 + x_3 = 4$
$2x_1 - 6x_2 - 3x_3 = 10$
$4x_1 - 9x_2 + 3x_3 = 4$

9. (10 points) Check whether the following functions are continuous and differentiable at some point.

1) (5 points)

$$f(x) = \begin{cases} -2x + 20, & x \leq 4 \\ -x + 16, & x > 4 \end{cases}$$

2) (5 points)

$$f(x) = \begin{cases} 3x, & x < 2 \\ 8 - x, & x \geq 2 \end{cases}$$

10. (10 points) Answer the following questions.

1) (5 points) Keynesian national-income model is as follows:

$\mathrm{Y} = \mathrm{C} + I_0 + G_0$
$\mathrm{C} = 80 + 0.6\,\mathrm{Y}$

$$I_0 = 30, \quad G_0 = 10$$

Compute the equilibrium C^*, Y^*.

2) (5 points) The demand and supply functions for two markets are numerically as follows:

$Q_{d1} = 10 - 2P_1 + P_2$
$Q_{s1} = -2 + 3P_1$
$Q_{d2} = 15 + P_1 - P_2$
$Q_{s2} = -1 + 2P_2$

2) FINAL EXAM

Mathematics Final Exam

Fall 2018

_____
Student ID

Name:_____
DO NOT WRITE YOUR NAME ANYWHERE ELSE ON THIS TEST.

NOTE: I GIVE LOTS OF PARTIAL CREDIT ON TESTS. In mathematics tests, if you get an earlier part of a problem wrong, you can get most points on later sections of that problem as long as you are consistent; or if you explain exactly the steps you would do to answer the question.

1.

a. (5 points) Find the point elasticity of demand (with respect to own price) for the demand function $y = 50 - 2p$, at price $p = 5$.

b. (5 points) Over what range of prices is ε (point elasticity of demand) less than 1, and over what range of prices is it greater than 1?

2.

a. (3 points) Show that the production function

$$f(x) = -\left(\frac{2}{3}\right)x^3 + 10x^2 + 5x$$

has both a concave and a convex section.

b. (3 points) A single input x is used to produce output y. Show that if the production function is $y = x^{1/3}$, $x > 0$, then the production function is concave.

c. (4 points) **Continuation of Question b.** Show that the cost function, $C(y)$ is convex if the cost function is $C(x) = c_0 + rx$.

3. For the total cost function

$$TC(y) = y^2 + 10y + 25, \;\; y > 0$$

show that

a. (4 points) MC is less than AC where AC is falling.

b. (4 points) MC=AC at the point where the AC curve is horizontal.

c. (4 points) MC exceeds AC where AC is rising.

4. Find and arrange in vector/matrix notation the first- and second-order partial derivatives of the below functions.

a. (5 points) $f(x_1, x_2) = x_1^2 x_2$

b. (5 points) $f(x_1, x_2) = x_1^2 + x_2^2$

5.

a. (5 points) Use the sign of the second-order total differential to show that the function $y = 5 - (x_1 + x_2)^2$ is (weakly) concave.

b. (5 points) Determine the convexity/concavity property of the function

$$y = f(x_1, x_2, x_3) = x_1^{\alpha} + x_2^{\beta} + x_3^{\gamma}, \;\; \mathrm{x} \in \mathrm{R}^3_{++}, \;\; 0 < \alpha, \beta, \gamma < 1$$

6. Find the stationary values of the following functions and state whether they yield a local minimum, local maximum, or point inflection.

a. (4 points) $y = x^3 - 3x^2 + 1$

b. (4 points) $y = x^4 - 4x^3 + 16x - 2$

c. (4 points) $y = 2x / (x^2 + 1)$

7. (8 points) There is a firm which is producing two different products under the pure competition (So it is called a two-product firm). Since with pure competition the prices of both commodities must be taken as exogenous, denoted by P_{10}, P_{20}. Moreover, the firm's revenue function is

$$\mathrm{R} = P_{10} Q_1 + P_{20} Q_2$$

where Q_i represents the output level of the ith product per unit of time. Similarly, the firm's cost function is assumed to be

$\mathrm{C} = 2Q_1^2 + Q_1Q_2 + 2Q_2^2$

Using the first-order condition and the second-order condition, find optimal quantities Q_1^* and Q_2^* when maximizing profit and show that the maximum profit is actually a unique maximum.

8. (8 points) Use the implicit function rule to show that

$$x^2y^3 + 3xy^2 + y = 22$$

implies an explicitly defined function $y = f(x)$ at the point $(1, 2)$ and find the value of the derivative dy/dx at this point.

9.

   a. (5 points) Jessica deposited $2,000 at an annual interest rate of 9% compounded monthly. How much money did she have in the bank at the end of two years?

   b. (5 points) $4,000 is deposited at 0.25% interest rate per semester (six-month), compounded continuously. How much will be in the account after 3 years?

10. The expenditure function is $E = \overline{E} + 0.7Y - 100R$. The demand for money is $L = 30 + 0.2Y - 10.5R$. The money supply is $\overline{M}$.

   a. (5 points) Solve for equilibrium Y and R as function of autonomous investment $\overline{E}$ and the money supply $\overline{M}$ by using Cramer's rule (HINT: The expenditure is equal to the national income in equilibrium).

   b. (5 points) Show the effects on the equilibrium values of changes in $\overline{E}$ and $\overline{M}$ (comparative statics analysis).

EXAMPLES OF PROBLEM SETS

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Problem Set 1

1. Answer the following questions in the C&W (main textbook) textbook:
   a) Question #1 on p. 14
   b) Question #2 on p. 14
   c) Question #3 on p. 14
   d) Question #4 on p. 14
   e) Question #7 on p. 14
   f) Question #8 on p. 14
   g) Question #1 on p. 19
   h) Question #3 on p. 19
   i) Question #5 on p. 19
   j) Question #8 on p. 20
   k) Question #1 on p. 45
   l) Question #3 on p. 45
   m) Question #3 on p. 47
   n) Question #2 on p. 51
   o) Question #4 on p. 51
   p) Question #2 on p. 58
   q) Question #4 on p. 58
   r) Question #6 on p. 58
   s) Question #8 on p. 59
   t) Question #1 on p. 65
   u) Question #2 on p. 66
   v) Question #6 on p. 66
   w) Question #7 on p. 66
   x) Question #5 on p. 69
   y) Question #3 on p. 87

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Problem Set 2

2. Answer the following questions at the end of Chapter in the CW textbook (fourth edition):
   z) Question #1 on p. 93
   aa) Question #4 on p. 93
   bb) Question #4 on p. 98
   cc) Question #6 on p. 103

dd) Question #3 on p. 107
ee) Question #3 on p. 112
ff) Question #1 on p. 127
gg) Question #2 on p. 127
hh) Question #1 on p. 135
ii) Question #2 on p. 135
jj) Question #3 on p. 135
kk) Question #3 on p. 139
ll) Question #2 on p. 141
mm) Question #3 on p. 141
nn) Question #3 on p. 147
oo) Question #4 on p. 147

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Problem Set 3

3. Answer the following questions at the end of Chapter in the CW textbook (fourth edition):

pp) Question #1 on p. 152
qq) Question #2 on p. 160
rr) Question #3 on p. 161
ss) Question #7 on p. 161
tt) Question #10 on p. 161
uu) Question #1 on p. 165
vv) Question #2 on p. 165
ww) Question #2 on p. 169
xx) Question #5 on p. 169
yy) Question #1 on p. 177
zz) Question #3 on p. 184
aaa) Question #6 on p. 184
bbb) Question #2 on p. 186
ccc) Question #1 on p. 193
ddd) Question #2 on p. 204
eee) Question #5 on p. 204

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Problem Set 4

4. Answer the following questions at the end of Chapter in the CW textbook (fourth edition):

fff) Question #2 on p. 233
ggg) Question #3 on p. 241

hhh) Question #2 on p. 254
iii) Question #3 on p. 260
jjj) Question #3 on p. 267
kkk) Question #4 on p. 267
lll) Question #2 on p. 272
mmm) Question #3 on p. 272
nnn) Question #4 on p. 282
ooo) Question #7 on p. 282
ppp) Question #1 on p. 286
qqq) Question #3 on p. 290
rrr) Question #7 on p. 290
sss) Question #1 on p. 300
ttt) Question #5 on p. 301
uuu) Question #1 on p. 312
vvv) Question #4 on p.312
www) Question #2 on p.317
xxx) Question #4 on p.317
yyy) Question #1 on p. 330
zzz) Question #2 on p.341
aaaa) Question #1 on p.345
bbbb) Question #1 on p.355
cccc) Question #3 on p. 355