NAME: Key _____

MATH 1470 Fall 2005 Tintera

TEST 2: Malthus, Demographic Transition and Logistic Models. Covers Chapters 5-6

You may use calculators and one 8.5 by 11 inch page of handwritten notes. Please show all work on this test booklet. Partial credit is awarded only for work shown. Each problem is worth as indicated. Good luck!

For the first four questions, choose the best answer by circling the letter for that answer. (5 points each)

1. Which of the following correctly relate Malthus' terminology to modern terminology:

   A. Arithmetic growth is the same as logistic growth.
   B. Geometric growth is the same as linear growth.
   C. Arithmetic growth is the same as exponential growth.
   (D.) Geometric growth is the same as exponential growth.

2. Which of the following is NOT true about moving averages?

   ~~A.~~ They are a technique for smoothing out jittery data.
   (B.) They compare data to a fixed base. Indexing
   ~~C.~~ They can be either centered or trailing.
   D. They replace an entire data set rather than just a single value.

3. Which of the following is true about demographic transitions?

   A. Birth rates fall in a country before the death rates.
   (B.) The growth rates rise and then fall.
   C. The birth rate rises as a result of prosperity.
   D. The death rate rises as a result of industrialization.

4. Which of the following is NOT a characteristic of a logistic model?

   ~~A.~~ There is early exponential growth.
   ~~B.~~ The change, Δy, will be negative if y exceeds the carrying capacity.
   (C.) The rate of change of y is greatest when y is close to the carrying capacity. lowest
   ~~D.~~ The graph has a characteristic "S" shape.

5. Label each of the social conditions with the stage of a demographic transition they would be typically be found in. (1 point each)

Condition	Stage
Children become an economic liability instead of an economic asset.	III
A high birth rate is more or less offset by a high death rate.	I
A shift from agricultural to industrial activity.	II
A better food supply and more medical care translate into a lower death rate.	II
Women have higher levels of education.	III

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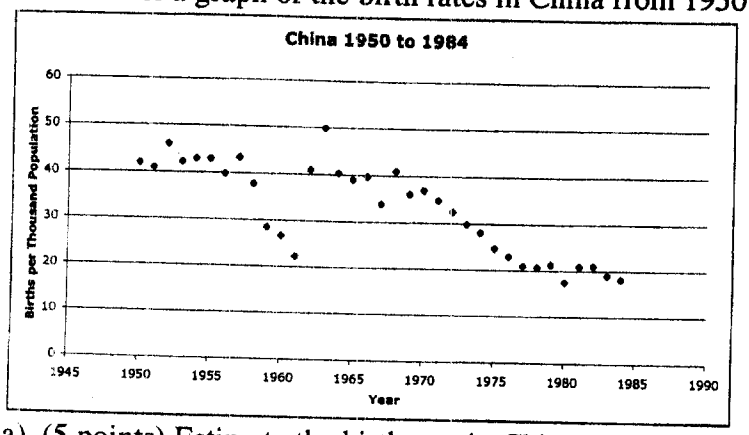
6. Below is a graph of the birth rates in China from 1950 to 1984.



a) (5 points) Estimate the birth rate in China in 1950 and express that birth rate as a percentage:
42 per thousand $\frac{42}{1000} = \frac{4.2}{100} = 4.2\%$

b) Based on the birth rate alone, give your best guess as to the stage of a demographic transition that China was in in 1985. Be sure that your answer shows me that you understand what a demographic transition is. (10 points)

The trend we see is that birth rate was high, then started decreasing, and then slowed its decrease toward the end. Based on this, I would guess that China is at the start of Stage 3 in 1985. ✓

7. The following data is about the population and food production in Poland:

Year	Population	Food	Δ Food
1962	30,419	64.8	
1966	31,478	75.9	11.1
1970	32,526	78.9	3
1974	33,706	88.3	9.4
1978	34,938	94.6	6.3
1982	36,259	85.6	-9
1986	37,446	101	15.4
1990	38,119	102.4	1.4

Does the production of food in Poland match what Malthus said about food production in general? Be clear about what he said, what you see and your conclusion. (10 points)

Malthus said that food production would increase linearly, and as we can see this is not the case above. So no, it does not match what Malthus said.

(the Δy's are differing greatly, thus non-linear) ✓

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8. The number, x, of feral cats on Ward Island seems to be governed by a the logistic model:

$$\frac{\Delta x}{\Delta t} = \overset{a}{0.06}x - \overset{b}{0.0005}x^2$$

a) (5 pts) Find the maximum number of feral cats on Ward Island predicted by the model.

$L = \frac{a}{b} = \frac{0.06}{0.0005} = 120$

$L = 120$ ✓

L = is maximum carrying capacity

b) (5 pts) If there were 10 feral cats on Ward Island one year, how many would there be the next year?

old y + Δy

$10 + 0.06(10) - 0.0005(10)^2 = 10.55$ feral cats next year ✓

c) (5 pts) When would there be the greatest increase in the Ward Island feral cat population?

$X = \frac{L}{2} = \frac{120}{2} = 60$ ✓

9. The percentage of students in a modeling course who had completed a reading quiz grew at a relative growth rate of 8% per day but leveled off with 90 percent of the students completing the reading quiz.

Either write a logistic model for this situation (being sure to explicitly defining the variables used) or explain why it would not be appropriate to use one. (10 points)

It would not be appropriate to use a logistic model at this point only because you do not have all of the needed data. There is an early growth rate and the leveling off could suggest the peak or carrying capacity but w/out knowing the number of students the L cannot be calculated, leaving the logistic model unfinished. A logistic model is appropriate w/ the known data.

$\frac{\Delta y}{\Delta t} = 0.08\,y\left(1 - \frac{y}{L}\right)$

y = number of students who completed the reading quiz

t = time in days

L = carrying capacity = 90% of ~~students~~ = maximum # of students who took the quiz ✓

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10. Below is a spreadsheet of the population and food supply for Mexico for the years given.

	A	B	C	D	E	F	G
1	Year	Mexico Pop.	Corn Production	3 Yr Trailing Mvg Avg—Corn	Per Capita Corn	Indexed Corn (Base = 1989)	Annual %Growth in Pop
2	1986	77,015	11,910		?		
3	1987	78,561	11,607				
4	1988	80,109	10,592	?			
5	1989	81,663	10,953				?
6	1990	83,226	14,635				
7	1991	84,801	14,251				
8	1992	86,386	16,929			?	

a) For each of the cells below, show the formulas as they would be entered into an Excel spreadsheet. Where appropriate, put $ signs to indicate values that don't change. (5 points each)

D4: = average (B2 : B4) 3

E2: = C2 / B2 ✓

F8: = (C8 / C$5) * 100 4

G5: = ((B5 - B4) / B4) * 100 ✓

b) Into which cells in the table above could the formula in cell D4 be copied? You should assume that row 8 is the last row in the table. (5 points)

D4 to D8 ✓

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