

Name: Solution

Hour: \_\_\_\_\_

**Quiz 7: First Order Differential Equations (DEs)**

Time: 20 Minutes	References: Basic Calculator, Ref. Sheet, and laptop (no connectivity)	Based out of 100%
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1. Your mother just took her famous apple pie out of the oven, with a temperature of 400 °F and it is well known that her pies cool according to the below DE when the room temperature is 70 °F:

$$\frac{dT}{dt} = -0.1(T - T_s)$$

Determine the temperature of the pie after 10 minutes by demonstrating Euler's method using a step size of 5 minutes.

i	h=0.5 t	T	T' = -0.1(T-70)
0	0	400	-0.1(400-70) = -33
1	5	400 + 5(-33) = 235	-0.1(235-70) = -16.5
2	10	235 + 5(-16.5) = <u>152.5</u>	

T(10) = 152.5 °F

2. Right after the Marine battle for Fallujah the city's population was 20,000 people, 250 of which were insurgents who were well mixed throughout the population. For some time after the battle the city experienced a transient period in which 50 new people entered daily with an average of 3 insurgents amongst them. However, it is also known that a representative sample of the city population emigrated out of the city at a rate of 50 per day.

a. Set up the DE model that describes the rate at which the number of insurgents in the city changes with respect to time (be sure to define your dependent variable).

Rate in =  $\frac{50 \text{ people}}{\text{day}} \cdot \frac{3 \text{ insurgents}}{80 \text{ people}} = \frac{3 \text{ insurgents}}{\text{day}}$

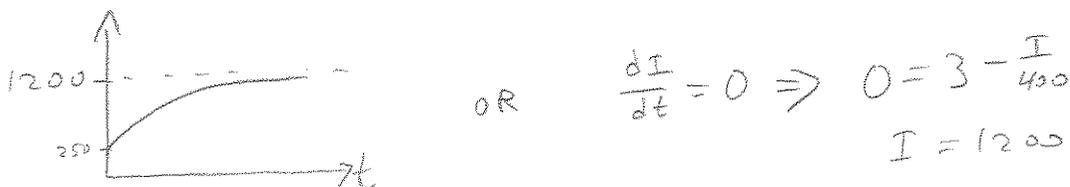
$I(t)$  = insurgents in Fallujah at time  $t$

$\frac{dI}{dt} = 3 - \frac{I}{400}$

$\frac{50 \text{ people}}{\text{day}} \cdot \frac{I(t) \text{ insurgents}}{20000 \text{ people}} = \frac{I(t) \text{ insurgents}}{400 \text{ day}}$



b. In the long run how many insurgents will be hiding out in Fallujah?



long run  $\Rightarrow$  1200 insurgents  
 ANS.