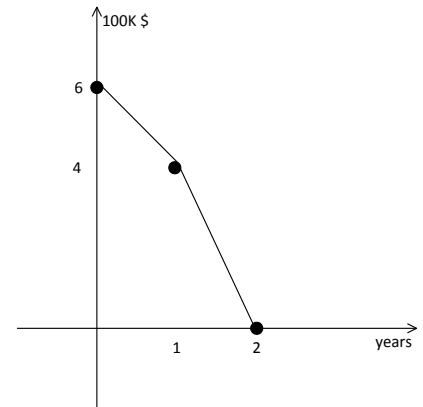


**Do not let the people copy out your homework, everyone must show their own work. In case of a violation, all homeworks may be graded as zero. All answers must be clearly stated, the responsibility of insufficient (or unclear) explanation belongs to the student.**

1. (20 pts) The net profit of a company decreased dramatically and the profit was close to zero last year. It is shown in the Figure. A profit/loss projection is needed to schedule the action plan. The same trend is expected since there is no significant change in market situation. The minimum squares estimation method will be used to determine the profit/loss.
  - a. Use a linear function to estimate the profit/loss in this year. ( $y=C+D \cdot t$ )
  - b. Use base-2 exponential function to estimate the profit/loss in this year. ( $y=C+D \cdot 2^t$ )
  - c. Use a parabolic function to estimate the profit/loss in this year. ( $y=C+D \cdot x + D \cdot x^2$ )
  - d. Which estimation gives better result, Why? Comment on the results.



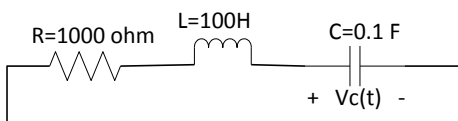
2. (15 pts) An experiment is conducted to measure the body weight effect and the age effect on the blood glucose concentration. 6 people are used in the experiment and the results can be seen in the table below (The mean values are subtracted from all data sets, **you can use the values given in the table directly**). Find the age-glucose level and body weight-glucose level correlations. Comment on the results, which has higher correlation?

Age (Mean: 41.2)	Body Weight (Mean: 72 kg)	Glucose level (Mean: 81.8 mg/dl)
1.8	38	17.2
-20.2	-15	-15.8
-16.2	-10	-1.8
0.8	-7	-5.8
15.8	-2	6.2
17.8	-4	0.2

3. (15 pts) Show that scalar multiplication (inner product) of two unit vectors gives the cosine of the angle between these vectors. (**Do not use any formula**)

4. (15 pts) Show that the determinant satisfies the given equation.  $\det \begin{pmatrix} a_1 & a_1 & a_1 & \dots & a_1 \\ 1 & a_2 & 1 & \dots & 1 \\ 1 & 1 & a_3 & \dots & 1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & 1 & 1 & \dots & a_n \end{pmatrix} = a_1(a_2-1)(a_3-1)(a_4-1)\dots(a_n-1).$

5. (35 pts) Consider the following electric circuit. The initial condition are  $V_c(0)=2V$  and  $i_L(0)=1 \text{ mA}$ . (**Use the given formulas which are extracted using kirshoff laws**).
  - a. Find the voltage expression across the capacitor  $V_c(t)$ ? What is steady state value of  $V_c(t)$ ?
  - b. Find a new initial condition set ( $V_c(0)=?$  and  $i_L(0)=?$ ) that results in shortest time to reach the steady state.



$V_c(0)=2v$   
 $i_L(0)=1mA$

$$iR + L \frac{di}{dt} + V_c = 0 \quad \text{yields} \quad V_c''(t) + \frac{R}{L} V_c'(t) + \frac{1}{LC} V_c(t) = 0$$

$$i = C \frac{dV_c}{dt}$$

**The initial conditions:**  $i_L(0) = C \frac{dV_c(0)}{dt} \Rightarrow V_c'(0) = \frac{i_L(0)}{C} = \frac{1mA}{100mF} = 0.01 \text{ V/s} \rightarrow V_c'(0)=0.01 \text{ V/sec}$  and  $V_c(0)=2V$ .