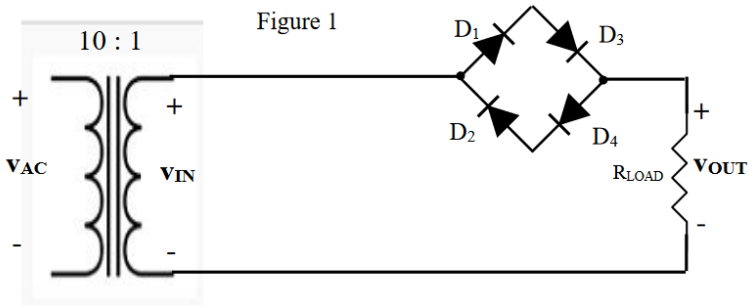
Exam 2 (Spring 2022)

1. A design engineer tries the configuration in Figure 1 for a rectifier circuit. He uses identical diodes D_1, D_2, D_3, D_4 that can be modeled with a constant voltage drop model with $\mathbf{V_{D0}}$ = 0.5V.
   The sinusoidal input signal at v_{AC} is 120Vrms at 60Hz. R_{LOAD} = 5KΩ

Figure 1



For his design

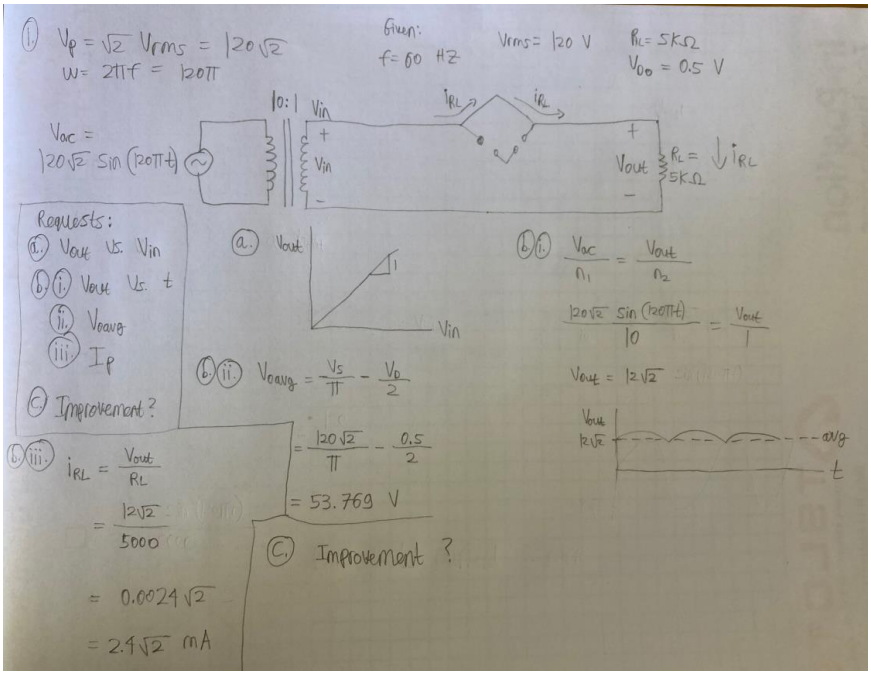
(a) Plot the v_{OUT} vs. v_{IN} for the circuit. Clearly indicate the values of all significant points and slopes of all segments. Label all axes. [20 points] (b) For the given input [15 points]

(i) Draw the corresponding output voltage v_{OUT} vs. time.

(ii) Find the average value of the output voltage v_{OUT}.

(iii) Find the peak diode current in each diode.

(c) What change can he do to his design to improve its performance. Explain your answer clearly. [5 points]



2. A designer has to build a regulator circuit as shown in Figure 2 using one of two types of diodes.
   Given that **both types of diodes** have a voltage of 0.9V at 1mA current. For the diode **of TYPE A** the voltage changes by 0.1V/decade change in current while for the diode **of TYPE B** the voltage changes by 0.1V when the current through it doubles.
   Do not assume the value for V_T.

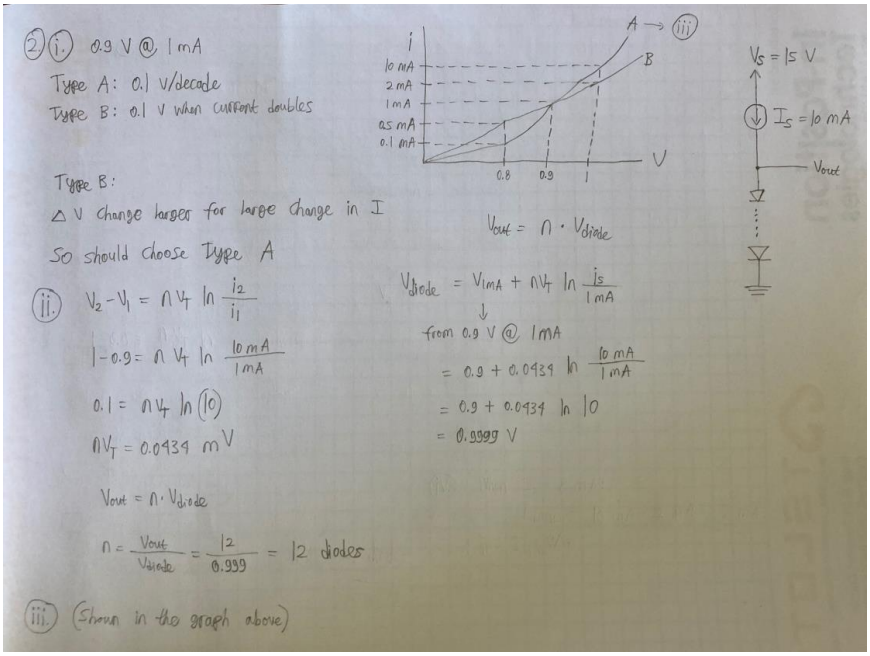
   The regulator needs to provide an output voltage v_{OUT} of 12V and be designed to have good performance for a load current range from no load to 8 mA.

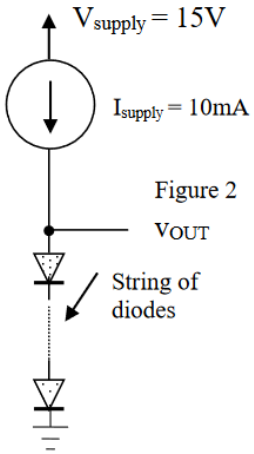
   (i) Which type of diode should the designer pick for building a regulator that has good performance? Clearly explain the reasons for your choice and what performance you were optimizing for. [8]

   (ii) How many diodes of the type chosen in (i) would be in the string to obtain the required v_{OUT} at nominal I_{supply} and no-load condition. [10]

   (iii) Draw the i-v curve of the diode chosen in (i). Mark the operating point at nominal supply and no load. Clearly label all axes and critical points on the graph. [8]

   (iv) What is the percentage change in the output when a 8mA load current is drawn from the regulator. [10]





Diode Rectifiers

1. A center-tapped transformer is used to configure a rectifier as shown in Figure 1 where identical diodes D_1, D_2, D_3 and D_4 are used. Assume that these diodes are **ideal**. The input v_{IN} is a sinusoidal input.

For each half cycle of the input (positive half (Fig. 1(a)) and negative half (Fig. 1(b)): (i) Find and indicate the state (ON or OFF) of the diodes. (ii) Clearly mark the current flow in the circuit and clearly indicate the direction of the current ***in the diodes and load resistors*** RL1 and RL2.

(iii)If the input $v_{IN} = 170\sin 2\pi 60t$ is given to the circuit, draw the input v_{IN} and the corresponding outputs v_{OUT1} and v_{OUT2} across the loads.

(iv) What is the average value of v_{OUT1} and v_{OUT2}.

(v) What is the peak diode current in each diode

(vi) what is the maximum reverse voltage seen by each diode.

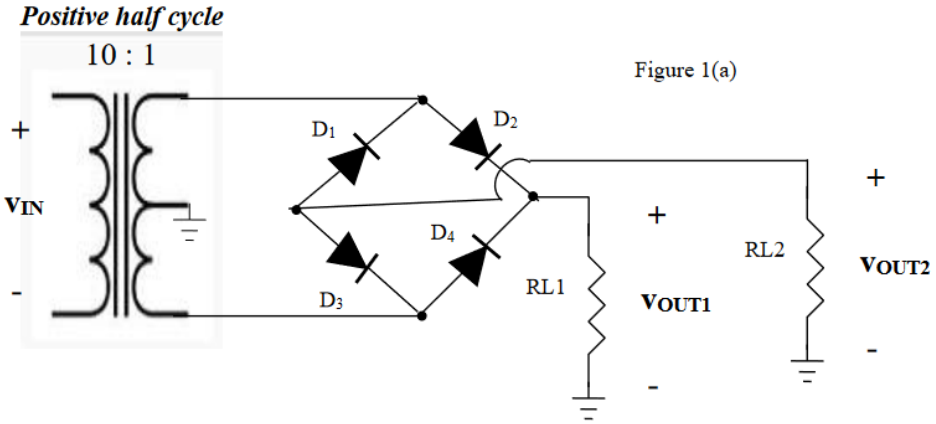


Figure 1(a)

Negative half cycle

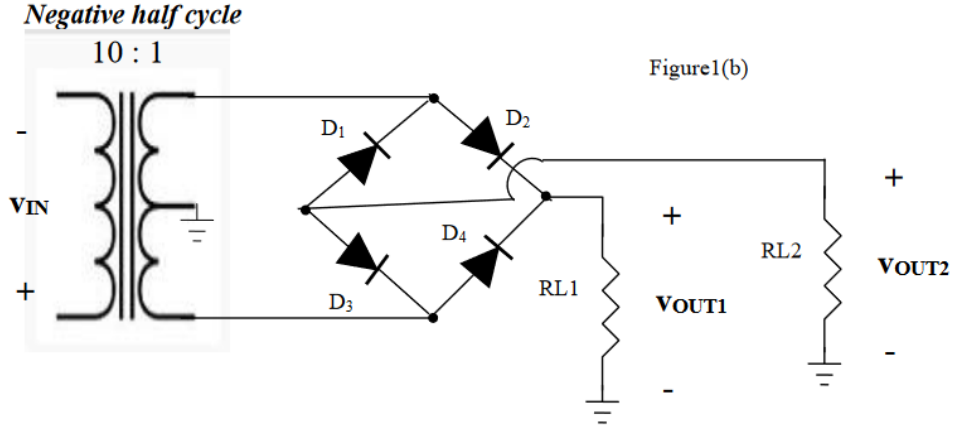
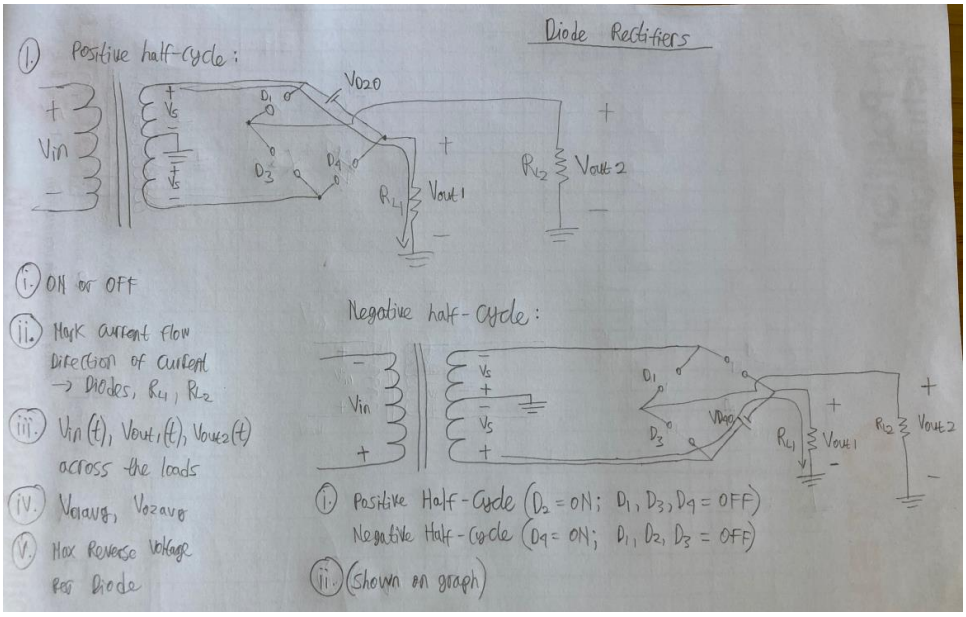
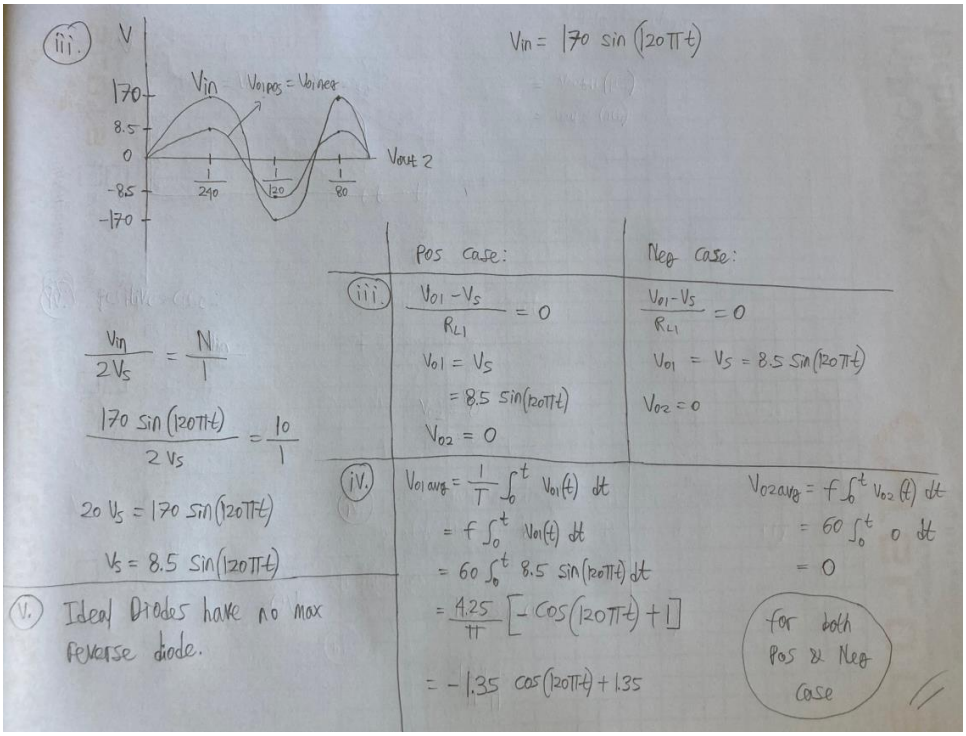


Figure1(b)





Diode Regulator

1. A voltage regulator is shown in Figure 1 A supply current of I_{IN} =10mA is provided. The diodes D_{1a}, D_{1b}, D_{1c}, and D_{1d} have a 0.65V drop at a current of 1mA and their voltage changes by 0.1V/decade change in current.
   (i) Draw the i-v curve for the diodes D_{1a}. Label axes and all relevant points. Clearly mark the operating points of the diodes on the graph.
   (ii) What is the output voltage V_{OUT} obtained for the designs under no load conditions? **Clearly show the steps of your work**.
   (iii) What is the load regulation ($\Delta V_{OUT}/\Delta I_L$) for a load current variation of 0mA to 4mA.
   What is the percentage change in V_{OUT}

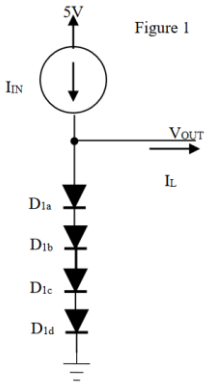


Figure 1

Diode Regulator

1. 5 V
I_{in} = 10 mA
V_{out}
I_L
D_{1a}
D_{1b}
D_{1c}
D_{1d}
0.65 V @ 1 mA
0.1 V/decade

i. i
10 mA
1 mA
0.1 mA
0.55 0.65 0.75 V

ii. $V_{D1a} = V_{D1b} = V_{D1c} = V_{D1d} = V_{D1(a\ to\ d)}$

$V_{D1(a\ to\ d)} = 0.75$ due to $I_{in} = 10\ mA$

$V_{out} = n \cdot V_{D1(a\ to\ d)}$
$= 4 \cdot 0.75$
$= 3\ V$

i) i-V curve for D_{1a}
ii) V_{out} obtained
iii) $\Delta V_{out}/\Delta I_L$ for I_L variation from 0mA to 4mA
↓
Have to find $V_{D1(a\ to\ d)}$ @ 0 mA, 4 mA

iii. $V_2 - V_1 = n V_T \log\left(\frac{i_2}{i_1}\right)$

$0.75 - 0.65 = n V_T \log\left(\frac{10\ mA}{1\ mA}\right)$

$0.1 = n V_T \cdot 1$

$n V_T = 0.1$

$V_{D1(a\ to\ d)} = V_{0mA} + n V_T \ln\left(\frac{4\ mA}{\ }\right)$