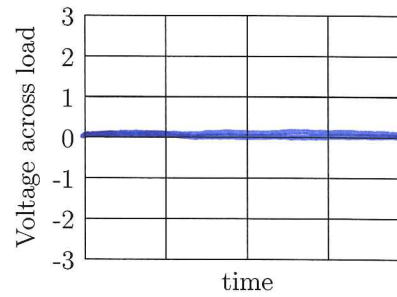
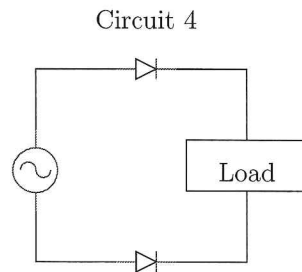
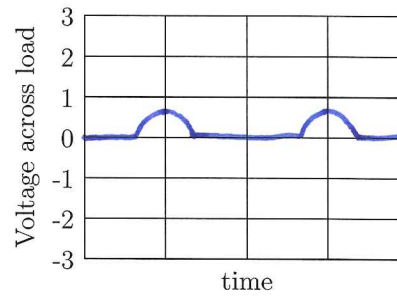
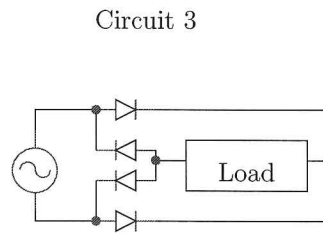
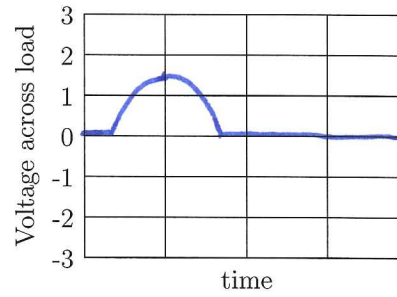
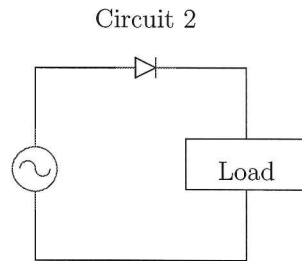
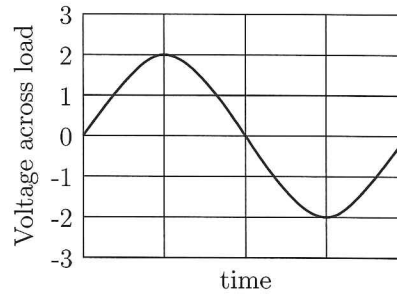
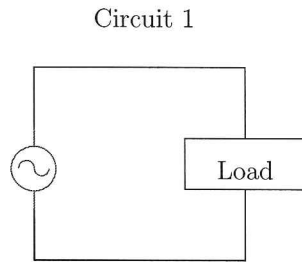


Physics 261
Exam 2

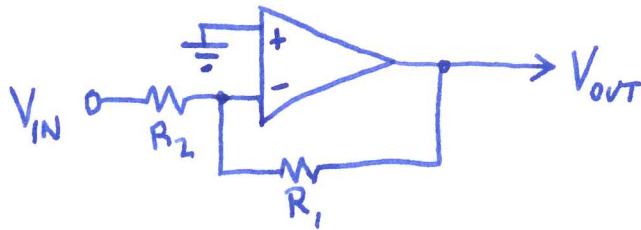
Remember to show your work.
40 points possible.

Name: SOLUTIONS

1. (6 points) In Circuit 1 and its accompanying graph, a time-dependent alternating voltage is applied to the load. Plot the voltage on the load in circuits 2, 3 and 4. Assume that the diode drop is 0.7 V.



2. (8 points) Design a circuit for which $V_{out} = -\frac{1}{2}V_{in}$.



$$V_+ = V_- = 0.$$

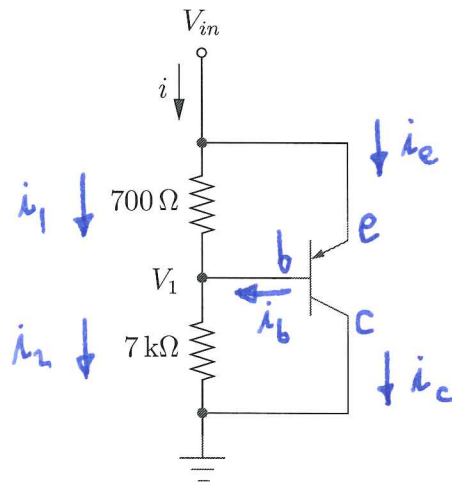
$$\frac{V_{IN}}{R_2} + \frac{V_{OUT}}{R_1} = 0$$

$$\Rightarrow V_{OUT} = -\frac{R_1}{R_2} V_{IN}$$

TO GET A GAIN OF $-\frac{1}{2}$ AS DESIRED,

WE COULD CHOOSE $R_1 = 1k$, $R_2 = 2k$.

3. In the circuit below, the turn-on (junction) voltage is $V_T = 0.7V$; $\beta = 100$.



- (a) (3 points) Label the base **b**, emitter **e** and collector **c**.
 (b) (4 points) For what values of V_{in} is the transistor in cutoff mode?
 (c) (3 points) Assuming cutoff mode, what are i and V_1 in terms of V_{in} ?
 (d) (8 points) Now assume the transistor is active. Find V_1, i_b, i_c, i in terms of V_{in} .

(b) $V_{IN} - V_1 = 0.7V, i_b = i_e = i_c = 0.$

$$V_1 = \frac{7k}{7.7k} V_{IN} \text{ (V-DIVIDER)}$$

$$\Rightarrow V_{IN} \left(1 - \frac{7}{7.7}\right) < 0.7V$$

$$\Rightarrow V_{IN} < 7.7V$$

(c) $V_1 = V_{IN}/1.1$

$$i = \frac{V_{IN}}{7.7k\Omega}$$

(d) $V_1 = V_{IN} - 0.7V$

(e-b JUNCTION) ACTS AS A DIODE, TRANSISTOR IS "ON".

$$i_1 = \frac{V_{IN} - V_1}{700\Omega} = \frac{0.7V}{700\Omega} = 1mA$$

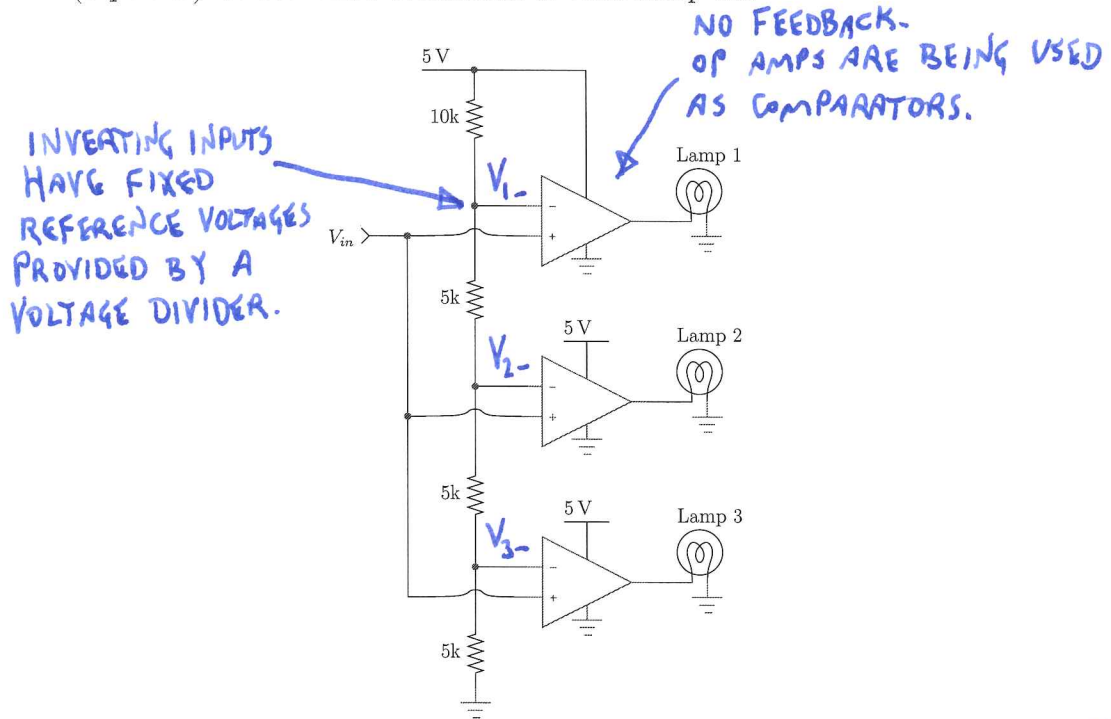
$$i_2 = \frac{V_1}{7k\Omega} = \frac{V_{IN} - 0.7V}{7k\Omega} = \frac{V_{IN}}{7k\Omega} - 0.1mA$$

$$i_b = i_2 - i_1 = \frac{V_{IN}}{7k\Omega} - 1.1mA$$

$$i_c = \beta i_b = 100 \frac{V_{IN}}{7k\Omega} - 110mA$$

$$i = i_2 + i_c = 101 \frac{V_{IN}}{7k\Omega} - 110.1mA$$

4. (8 points) Under what conditions is each lamp lit?



$$V_{1-} = \left(\frac{15k}{25k} \right) 5V = 3V \Rightarrow \text{LAMP 3 ON IF } V_{IN} > 3V$$

$$V_{2-} = \left(\frac{10k}{25k} \right) 5V = 2V \Rightarrow \text{LAMP 2 ON IF } V_{IN} > 2V$$

$$V_{3-} = \left(\frac{5k}{25k} \right) 5V = 1V \Rightarrow \text{LAMP 1 ON IF } V_{IN} > 1V$$