EE2032 Electronics In-term Homework

June 4, 2020

INSTRUCTIONS FOR THIS HOMEWORK:

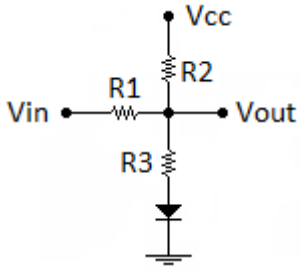
There are 3 problems in this homework. In some of them, there may be a parameter used specific to your student number. Let us call it ***S*** and define it as the sum of the last 3 digits of your student number. For example, if your number is 150117067, then ***S*** value will be 0+6+7=13. Similarly, ***S*** value for the student number 150117829 will be 19.

Note that, the problems have infinitely many correct answers. Choose the free values used in your answers random enough to avoid coming up the exact same answers with any other students by chance. The completely same answers, and, the same solutions may be considered as cheating for *both* students! Normally this is not expected to happen in this homework since ***S*** value used in the problems is different enough for students, and there is a set of huge alternatives for the free parameters that may be preferred.

Please show all your work, write legibly, and, indicate your answers clearly. Preferably, use a single sheet for each problem solution. At the end, combine all sheets together as a single *pdf* file and upload it to the system *in time*. The problems are clear enough, and, no questions may be asked to the instructor or any other person during this period. You can use books and the course web page http://mimoza.marmara.edu.tr/~mdogruel/EE2032/ for help if necessary. However, it is important that *no aid may be given or received from any person* for this homework. Pledge this in writing.

PROBLEMS:

(30 pts.) **1)** The diode used in the following circuit is (0.7 Volt) ideal. We would like to obtain the output voltage as Vout = ***S*** (in unit of volts) where ***S*** is as defined in the instructions. Suggest proper Vin, Vcc, R1, R2, R3 values (together with their units) so that the diode is *on* and the current flowing from the diode is 100 mA.

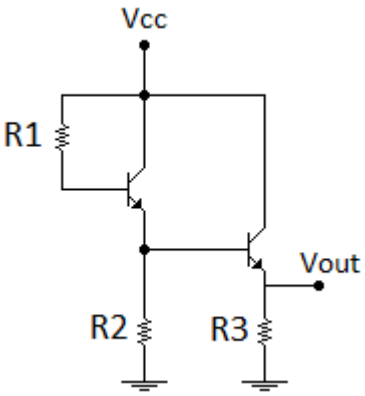


Your grade for this problem will be:

30 pts: if completely correct;
15 pts: if there is a minor mistake;
0 pts: if wrong, deficient, incomplete or no solution.

Therefore, please pay attention and make sure that your calculations are correct, and, your answer satisfies the required conditions.

(35 pts) **2)** For the circuit given, we would like to obtain the output voltage as Vout = ***S*** (in unit of volts) where ***S*** is as defined in the instructions. We would like the total current supplied from Vcc as 100 mA. The transistors must work in the active region, and they have the same current gain parameter of β. $V_{CE(sat)}$=0.2 V.



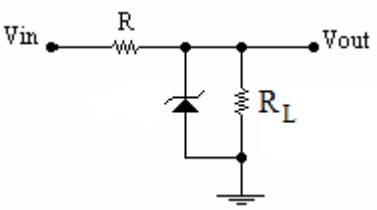
Suggest proper values for Vcc, R1, R2, R3, and β.

Your grade for this problem will be:

35 pts: if completely correct;
15 pts: if there is a minor mistake;
0 pts: if wrong, deficient, incomplete or no solution.

Therefore, please pay attention and make sure that your calculations are correct, and, your answer satisfies the required conditions.

(35 pts) **3)** Design a voltage regulator circuit such that the input voltage range is 6 to 10 V, and, the required output voltage is 5 V. The load resistor value, R_L, is ***S*** kΩ (where ***S*** is as defined in the instructions). For example, if ***S***=13, R_L=13 kΩ. Suggest a proper R value, and find the maximum powers of the three elements used in the circuit. Your grade for this problem will be as indicated in Problem 2.



EE2032 In-term Homework Solutions

Note that: S is an integer number between 1 and 27.

1) We have:

(S - 0.7)/R3 + (S - Vin)/R1 + (S - Vcc)/R2 = 0
(S - 0.7)/R3 = 100mA

We find: R3= (S - 0.7)/0.1
The other values, Vin, Vcc, R1, R2, can be selected so that (S - Vin)/R1 + (S - Vcc)/R2 = -0.1

These must be true at the end:
Vout = (0.7/R3+Vin/R1+Vcc/R2)/(1/R3+1/R1+1/R2) must be S
Id = (Vout - 0.7)/R3 must be 0.1

2) We have:

Ib1=(Vcc - 0.7 – 0.7 - S)/R1
Ib2=(β+1)Ib1 – (S + 0.7)/R2
S/R3 = (β+1)Ib2
Ib1 + βIb1 + βIb2 = 0.1

To keep in the active region, we need:
Ib1 >0, and, (Vcc – 0.7 - S) > 0.2 for the first transistor, and,
Ib2 >0, and, (Vcc - S) > 0.2 for the second transistor.

The values, Vcc, R1, R2, R3, and β, can be selected satisfying the above equations.

These must be true at the end:
Vout = (((β+1)^2(Vcc-1.4)/R1 - 0.7(β+1)/R2)/(1/R3+(β+1)^2/R1+(β+1)/R2) must be S
Icc = (β+1)(Vcc – 1.4 - Vout)/R1 + (Vout/R3)β/(β+1) must be 0.1
Vcc must be greater than (Vout + 1.4)

3) We need:

6S/(S +R) > 5

R can be selected (as a positive number) from this inequality.

Then the maximum powers are:

Pmax_R = (10-5)^2/R
Pmax_RL = 5^2/S
Pmax_Z = ((10-5)/R - 5/S)*5