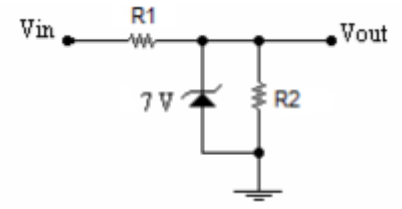
EE2032 Electronics Quiz#4

5) Consider the voltage regulator circuit for keeping V_{out} =7 V. The zener diode has the maximum power of P_{ZM}=0.5 W.
a) What must be the range of the load resistor R2, if R1=100 Ω and V_{in}=10 V?
b) What must be the range of the load resistor R2, if R1=30 Ω and V_{in}=10 V?
c) Carefully calculate and show all valid R1-R2 region in detail assuming V_{in}=10 V.
(Use the horizontal axis R1 for the values R1>0, and the vertical axis R2 for R2>0 in a two dimensional plot. The region and the bordering functions must be clearly indicated in detail.)

Answer:



We need: Iz>0, and for this we need R2/(R1+R2)*Vin>Vz
and we need Iz*Vz<P_{ZM} where Iz=(Vin-Vz)/R1-Vz/R2

a)
R2/(100+R2)*10>7
10*R2>700+7*R2
R2>233 Ohms
Iz=(10-7)/100-7/R2
IzMAX=30mA ➔ PZMAX=30mA*7=210mW. This is already less than P_{ZM} even if R2 is infinity.

b)
R2/(30+R2)*10>7
10*R2>210+7*R2
R2>70 Ohms
Iz=(10-7)/30-7/R2
Iz=100mA-7/R2
(100mA-7/R2)*7<0.5
0.7-49/R2<0.5
0.2<49/R2
R2<245
Therefor we need: 70<R2<245

c)
Lower Limit for R2 given R1:
R2/(R1+R2)*10>7 ➔ R2>2.33*R1

Upper Limit for R2 given R1:
((10-7)/R1-7/R2)*7<0.5 ➔ 3/R1 < 0.5/7 + 7/R2
➔ 7/R2 > 3/R1 -0.5/7
Therefore, if 3/R1<0.5/7, or, R1>42 there is no upper limit for R2.
When R1<42 we need:
R2<98*R1/(42-R1)