THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

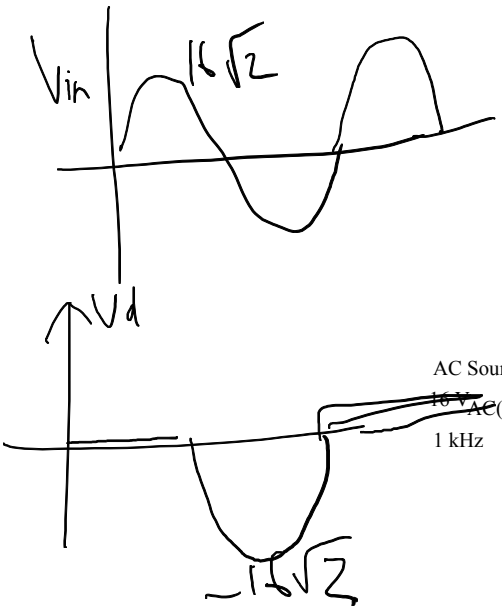
ENGINEERING

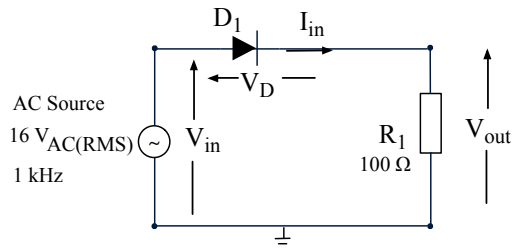
Department of Electrical and Computer Engineering

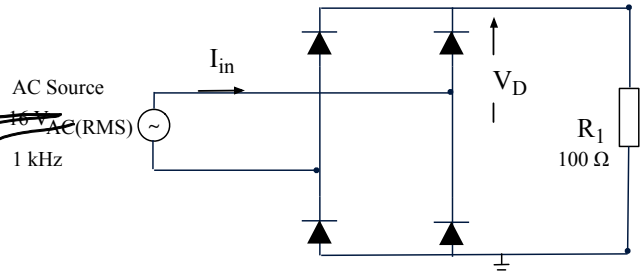
ELECTENG 209: Analogue and Digital Design

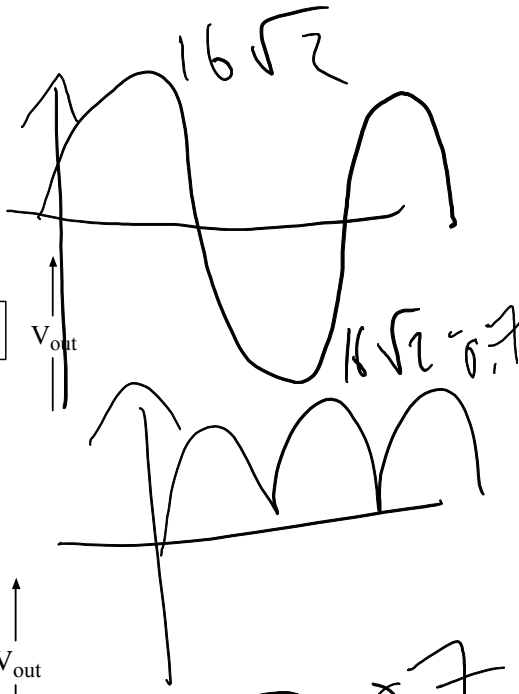
Tutorial – Rectifiers and Linear Regulators

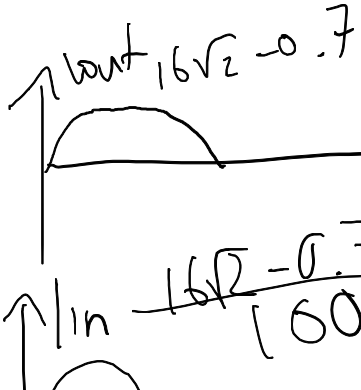
1. Sketch the V_{in}, V_D, V_{out} and I_{in} waveforms for the following four rectifier circuits. Clearly label your axis showing appropriate voltage, current and time values. What is the average and RMS values of V_{out} in each case and calculate the power delivered to the 100 Ω load. Assume a diode voltage drop of 0.7 V.

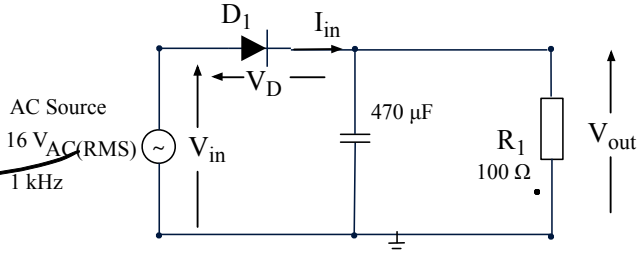


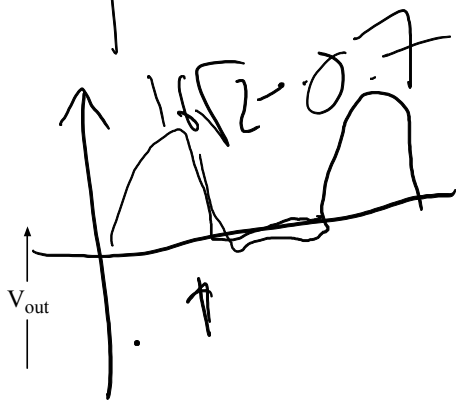


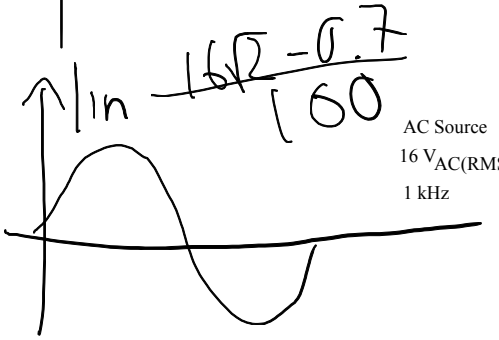


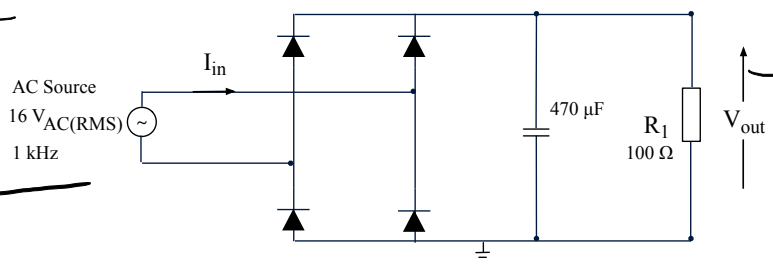












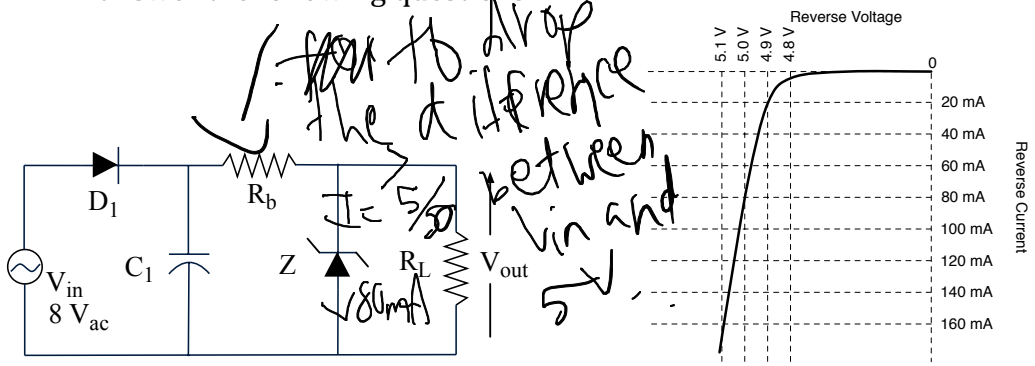
2. Sketch the forward and reverse transfer characteristics of a 3.3 V Zener diode.

3. With the aid of a sketch briefly discuss how you can use a Zener diode to protect an ADC pin of a microcontroller from over voltage conditions

4. With the aid of a sketch briefly discuss how you can use a signal diode to protect an ADC pin of a microcontroller from over voltage conditions

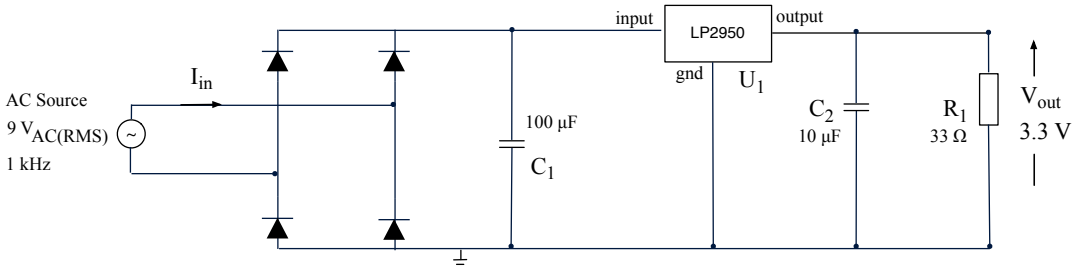
5. With the aid of a sketch briefly discuss how you can use Zener diodes to protect the input of the voltage amplifier stage in your design from over voltage conditions

6. A simple regulator circuit that utilizes a Zener diode (Z) to generate a regulated 5 Vdc output is shown below. The regulator is supplied by an 8 V_{ac} (RMS) source and is designed to supply a load (R_L) of 50 Ω. The breakdown characteristics of the Zener used in this circuit are shown next to the circuit diagram. Assuming a large filter capacitor (C_1) is used, answer the following questions.



- Briefly explain the purpose of the resistor R_b.
- Determine the value of R_b required to achieve an output voltage of 5 V when the load is 50 Ω.
- What will happen to the output voltage if resistance of R_L is increased
- What will happen to the output voltage if resistance of R_L is decreased

7. Stating any assumptions, determine the approximate peak-peak ripple voltage across C_1. What steps can you take to reduce the ripple voltage?



8. What are the advantages and limitations of linear regulators?
9. How does a linear regulator work?
10. How does a switch mode regulator work?