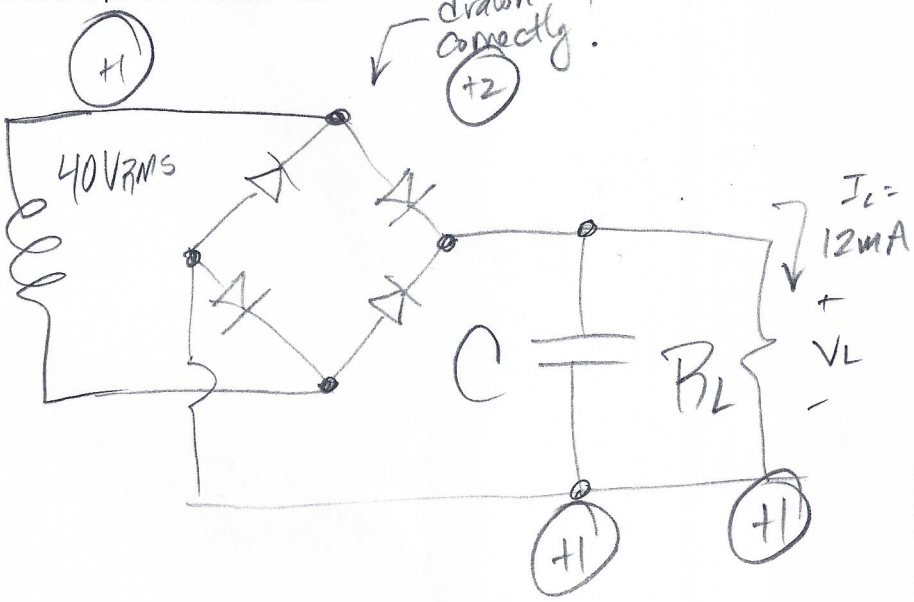
BME 3511 • Exam IV • 29 October 2021 — 32 pts. — NAME SOLUTION

A transformer secondary voltage of **40 V_{RMS}** is connected to a full-wave bridge rectifier and capacitor-input filter. Determine the value of capacitor that will achieve **less than 1% ripple** at a load current of **12 mA**, and choose the nearest commercially-available part. Also determine the voltage ratings of the capacitor and diodes, and choose a 1N400X-series diode. Finally, draw the circuit and determine the final output voltage. You do not need to show the primary side of the power transformer.



Final V_L

$= V_{peak} - \frac{1}{2} V_{ripple}$

$= 55.16 - \frac{1}{2} \cdot 0.5516$

$= 54.88\ V$ (+2)

$V_{peak} = V_{secondary}\sqrt{2} - 2 \cdot 0.7 = 40\sqrt{2} - 1.4 = 55.16\ V$ (+2)

$V_{ripple} \approx \frac{I_L}{2fC} \rightarrow C = \frac{I_L}{2f V_{ripple}}$

$V_{ripple} = 55.16 \times 0.01 = 0.5516\ V$ (+1)

$\therefore C = \frac{.012}{2 \cdot 60 \cdot 0.5516} = 1.813 \times 10^{-4}$ or $181.3\ \mu F$ (+2)

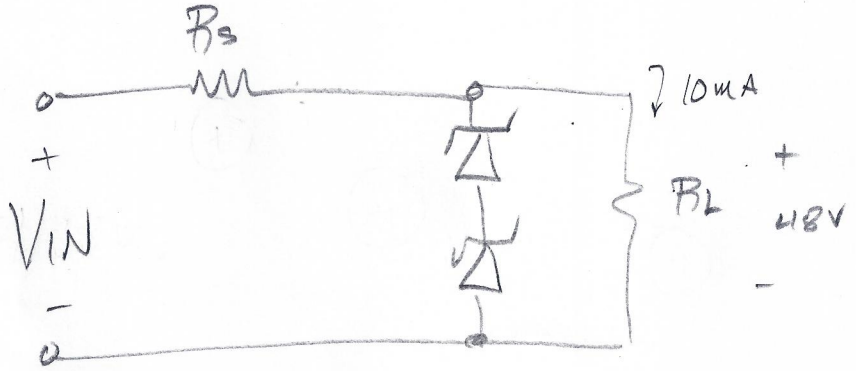
Use 220 μF (+1)

Cap voltage should be 63 V (standard value) (+1)

PIV $> \sqrt{2}\, V_s = \sqrt{2} \cdot 40 = 56.57\ V$ use 100V diode (+2)

1N4002 (+1)

Design a Zener regulator for the above power supply that achieves a final output voltage of **48 V @ 10 mA load current**. Set minimum Zener current to 2 mA. Choose an E24 value for R_S, and determine the power in each component. Note: 48 V is not an E24 value, so use two 24V Zener diodes in series (yes, this works, and each one only has to handle half the power!).



$\therefore V_{IN(min.)} = V_{peak} - V_{ripple} = 55.16 - 0.5516$

$= 54.61\ V$ (+2)

$\therefore R_S = \dfrac{V_{IN(min.)} - 48}{I_L + I_{Z(min.)}} = \dfrac{54.61 - 48}{.010 + 0.002}$

$= 550.8\ \Omega$ (+2) (usually round down to ensure min. I_Z, but close enough)

Use $R_S = 560\ \Omega$ (+1) (E24)

$P_{R_S} = I^2R = (.010 + .002)^2 \cdot 560 = 0.08064\ W$

[use anything; ¼ W etc.] (+2)

$P_{Z\,max} = I_{Z\,max} V_Z = .012 \cdot 24 = 0.288\ W$ (+2)

(each)

(½ W Zeners will be fine)

Design a relay circuit that will energize the 120V primary of the power supply you just designed from a **24VAC source located far away**. Show the primary circuitry, and assume the relay has both N/C and N/O contacts available. Include a snubber network and <u>fuse</u> in your circuit.