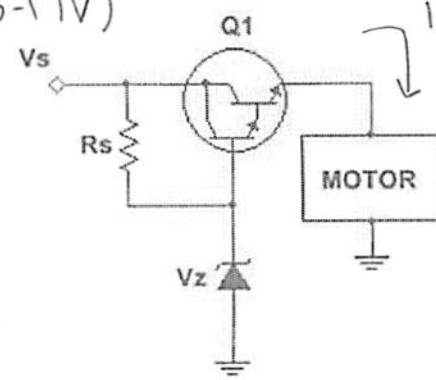
ECE 363 QUIZ 1 (F19) NAME: Solutions

1 problem for 20 pts

Emitter Follower Design

1) You are asked to design a power supply for a 12V DC motor. The input voltage V_S comes from a supply that can vary from ~~[illegible]~~ 15V to 17V. Here are the design constraints: (15-17V)



1A max

- Output voltage: must be within +/- 5% of 12V.
- The motor has a "no-load" current of 100 mA and a "stall" current of 2A. Design the power supply to provide up to 50% of the stall current.
- The zener must either be 11, 13, or 15V
- The Darlington transistor can either be a KSP13 or TIP120
- Available heat sinks are θ_{SA} = 6, 12, 18, and 24 °C/W (assume T_A = 25 °C and θ_{CS} = 0.5 °C/W).
- Use standard 5% resistor values.

(a) Using "quick" analysis assumptions, determine the appropriate zener diode voltage. Show all work!

(b) Perform a "quick" analysis to determine the appropriate transistor. If you need a heat sink, you must choose one of the available θ_{SA}. **You MUST explain why you chose one transistor and not the other one.**

(c) Using **"typical" parameters** for your choice of transistor from part (b), determine the appropriate resistor R_S (choose standard 5% value).

(d) Determine the proper power ratings for the zener and resistor. Choose from ¼, ½, 1, or 2 W rating.

(a) $V_{LOAD} = V_Z - 1.4 \rightarrow V_Z = 12 + 1.4 = 13.4V \rightarrow$ choose **13V zener**

+3

Check: $V_{Load} = 11.6V$ (−3.33% error) ✓

(b)

	Max I_C	P_{Rating} (no HS)	P_{rating} (with HS)
KSP 13	.5A ✗	.625W	
TIP 120	5A ✓	2W ✗	65W ✓

* KSP13 cannot handle current.

Power dissipation?

$$\text{Max}P = \frac{1A}{2501}(1.4V) + \frac{2500}{2501}(1A)(17-11.6)$$

$$= .00056 + 5.39784$$

$$\cong 5.4\,W$$

+7

Need heat sink!

(extra sheet for work)

$$1.92\ ^\circ C/W \qquad .5\ ^\circ C/W$$

Want $T_J = T_A + P(\theta_{JC} + \theta_{CS} + \theta_{SA}) < 85^\circ C$

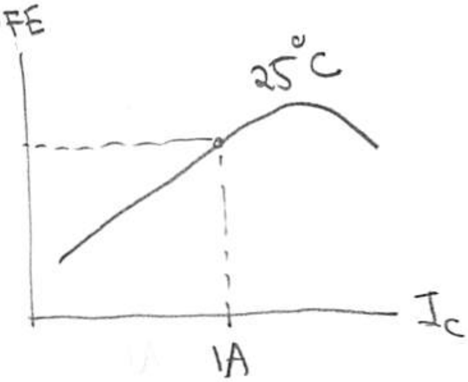
$$\theta_{SA} < \frac{85^\circ C - 25^\circ C}{5.4W} - 1.92\ ^\circ C/W - .5\ ^\circ C/W$$

$< \underline{8.69\ ^\circ C/W}$ Choose $\boxed{\theta_{SA} = 6\ ^\circ C/W}$

(c)

$$\text{Min } I_Z = \frac{15-13}{R_S} - \frac{1A}{3501} > .01A$$

~3500



+5

$R_S < 194\Omega$ ← Not critical to multiply by 0.95 for 5% resistor tolerance. ← $I_Z > 10mA$ is not super strict guideline.

Choose $\boxed{R_S = 180\Omega}$

(d) Resistor: $\text{Max } P = \frac{(17-13)^2}{180\Omega} = .089W \xrightarrow{\times 2} .178W$

+5

$\Rightarrow \boxed{1/4 W}$

Zener: $\text{Max } P = (\text{Max } I_Z) \cdot 13V$

$$= \left(\frac{17-13}{180\Omega} - \frac{1A}{3501}\right)(13V) = .285W \xrightarrow{\times 2} .57W$$

choose $\boxed{1W}$

However, 1/2 W would probably be OK.