FSK 224 Test 1 - 2013 (Memo).

(fsk224T1-2013memo.pdf)

Question 1

1.1. D

1.2. D

1.3. B

1.4 A

1.5 C

1.6 D

1.7 B

1.8 C

1.9 A

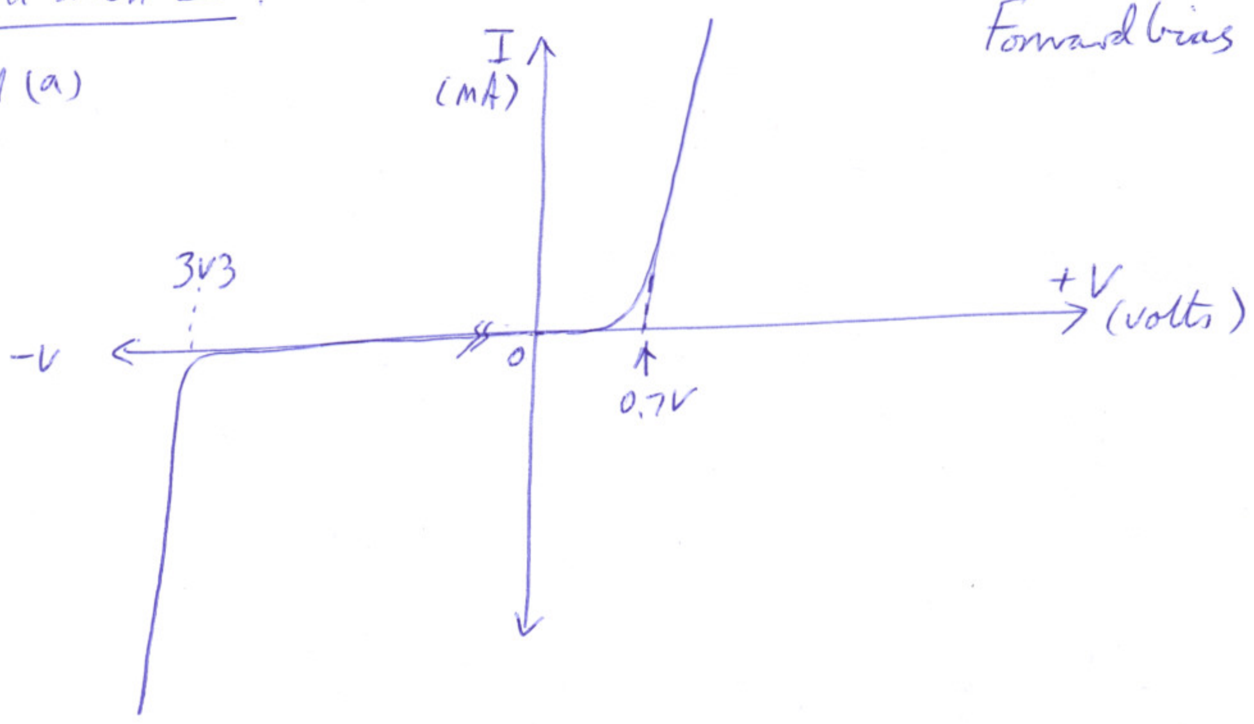
1.10 D

1.11 C

1.12 D

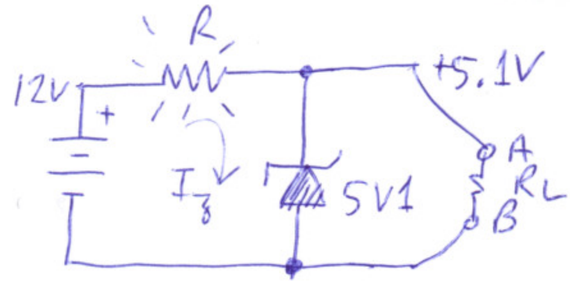
Question 2

2.1 (a)



(b) Possible solutions (there are several, some better than others).

Soln. (i)



$$P_z = \frac{P_{z\,max}}{2} \text{ (derate)}$$

$$= \frac{1}{2} = 0.5W$$

$$= I_z V_z$$

$$\Rightarrow I_z = \frac{P_z}{V_z} = \frac{0.5}{5.1} A = 0.09803A$$

$$= 98.03mA$$

$$= I_R$$

$$\therefore R = \frac{V_R}{I_R} = \frac{12 - 5.1 (V)}{0.09803 (A)}$$

$$= 70.4\,\Omega \quad (68\,\Omega \text{ standard})$$

$$P_R = I_R V_R = 0.09803(6.9)\,W$$

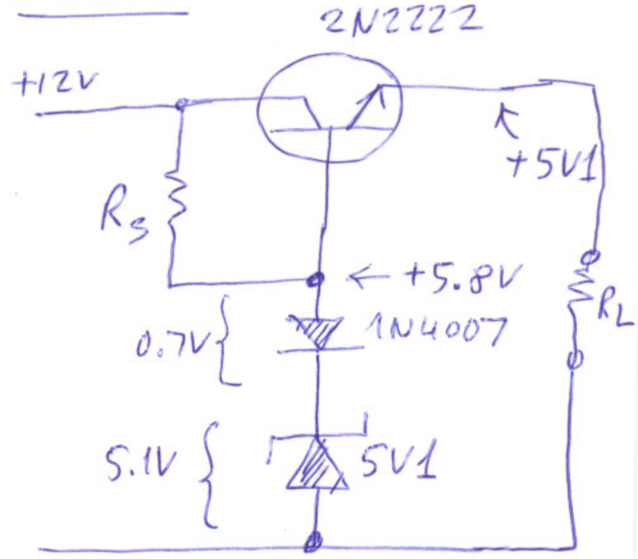
$$= 0.676\,W$$

Use a resistor of 68Ω rated at higher than 0.676W e.g. 1 Watt.

Main disadvantage of this circuit:

The load impacts the regulation of the output voltage. The lower the load, the greater the drop in the output voltage.

Soln. (ii)



Using similar reasoning, $R_S \geq 68\,\Omega$.

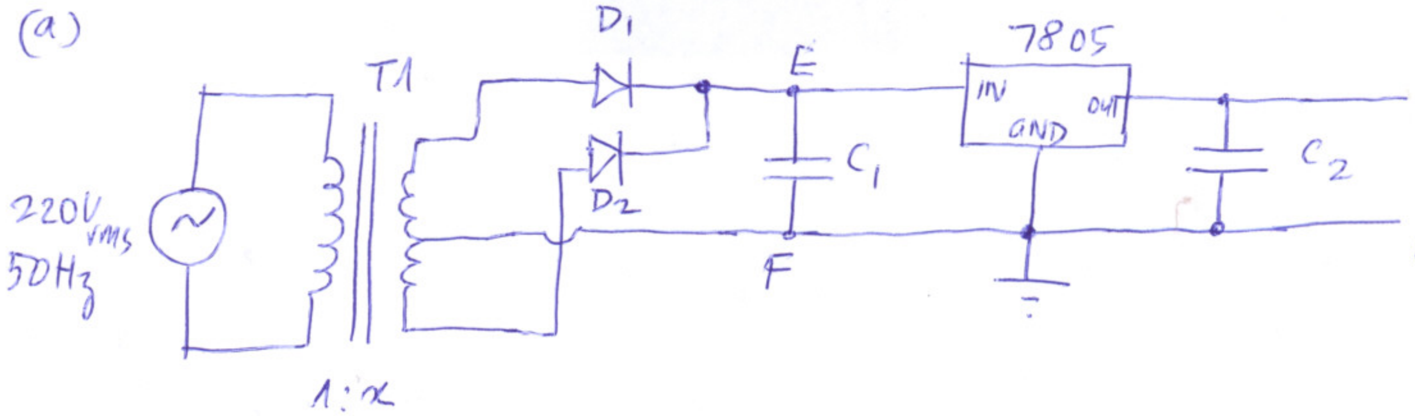
This circuit has the advantage that I_z can be kept much lower than 98mA since the transistor base current can be smaller.

$$I_E = (\beta + 1) I_B = I_L$$

where β = transistor forward current gain.

Q2.2

(a)



T1: Step down ^Mains^ transformer i.e.

$$V_S = \frac{220}{x} \ (V_{rms})$$

D1, D2: Rectifier diodes in half-wave configuration. Each diode handles 180° of the input. The effective voltage at (E) is $(V_{S,PK} - V_D)$

C_1: is a ripple suppression capacitor i.e. "smoothing" filter.

7805: is a three-terminal voltage regulator that produces +5V across A, B. The load is connected across A → B

C_2: is a high-frequency stabilization capacitor. It prevents the internal circuits of the 7805 from oscillating under certain conditions of loading.

Overall, the circuit produces a regulated, positive 5V (across AB) from the mains supply.

(b) Across C_1 i.e. point (E),

$$V_E = 8V = (V_{S,pk} - V_D)$$

$$\therefore V_{S,pk} = 8 + V_D = 8.7V$$

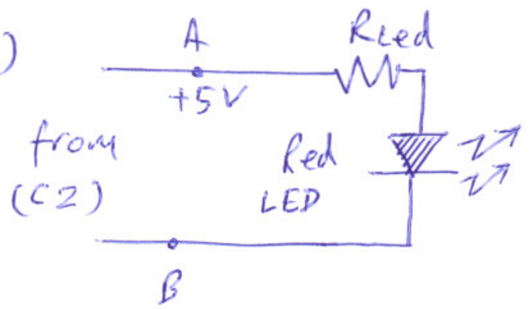
$$\Rightarrow V_{S,rms} = \frac{V_{S,pk}}{\sqrt{2}} = \frac{8.7}{\sqrt{2}}V = 6.15V$$

$$= \frac{V_{P,rms}}{x}$$

$$= \frac{220}{x}$$

$$\Rightarrow x = \frac{220}{6.15} = 35.77 \simeq \underline{35 \text{ or } 36}$$

(c)



$V_{Led} = 2V$

$I_{Led} \simeq 10mA$

$$\Rightarrow R_{Led} = \frac{V_{AB} - V_{Led}}{I_{Led}} = \frac{5-2}{10} \frac{(V)}{(mA)}$$

$$= 0.3K = 300\Omega$$

Use a 330Ω resistor, standard.

<u>Q2.4</u>

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{12-0.7}{R_2} = \frac{12-0.7}{240} \frac{(V)}{(K)} = 0.04708mA$$

$$= \underline{47.08\mu A}$$

$$I_C = \beta I_B = 50 \times 0.04708mA = 2.354mA$$

$$V_{CE} = V_{CC} - I_C R_C = V_{CC} - I_C R_1 = 12 - 2.354(2.2) = 6.8212V$$

$$\simeq +6.82V$$

Transistor characteristics

Load-line equation: $V_{CE} = V_{CC} - I_C R_C$

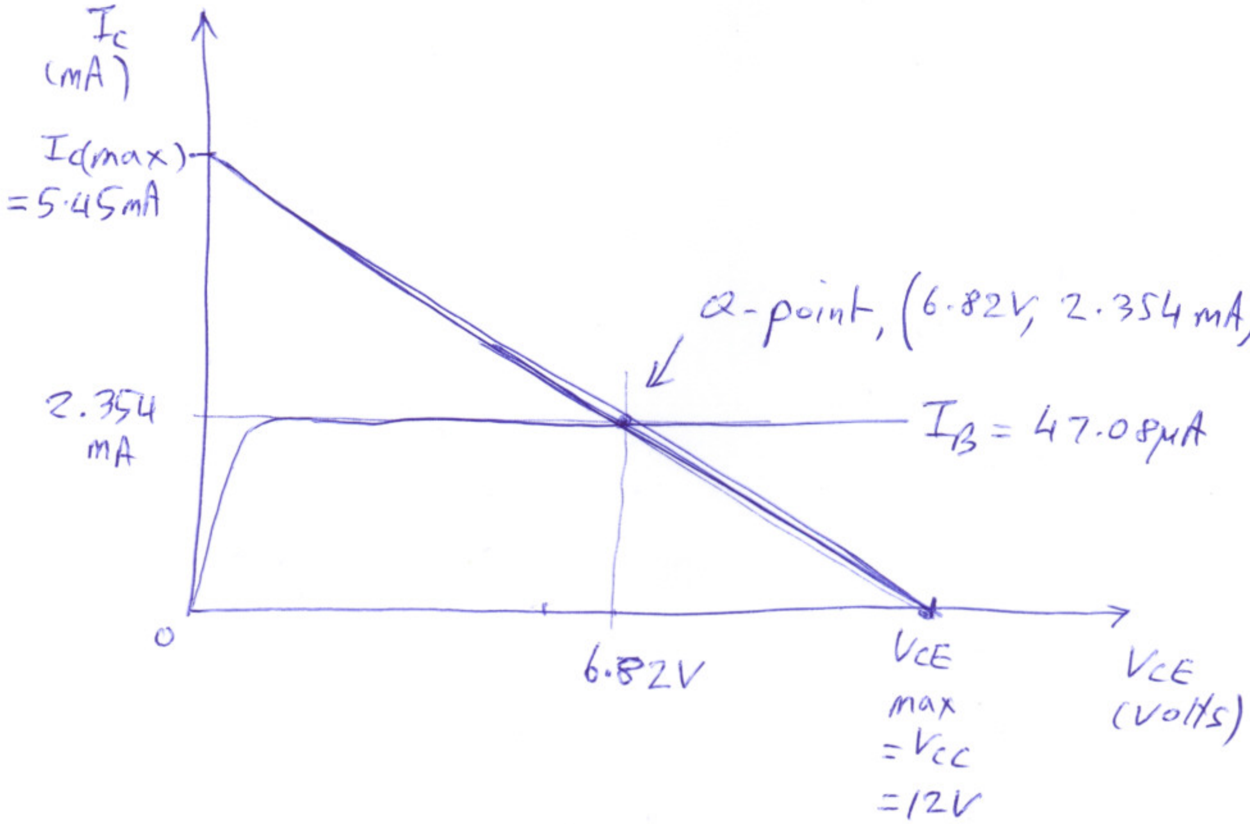
When $I_C = 0$, $V_{CE} = V_{CC}$

when $V_{CE} = 0$, $I_C = \frac{V_{CC}}{R_C} = \frac{12}{R_1} = \frac{12}{2.2}$ mA

$= 5.45$ mA

When $I_C = 2.354$mA, $V_{CE} = V_{CEQ} = 6.82$V, for $I_B = 47.08\mu A$.

With these values, the characteristic is as shown below –



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