EE3 Fall 2020
Practice Problems 7

1. Compute the forward resistance of the 1N4448 diode when working in the normal operating range of 4-20 mA.

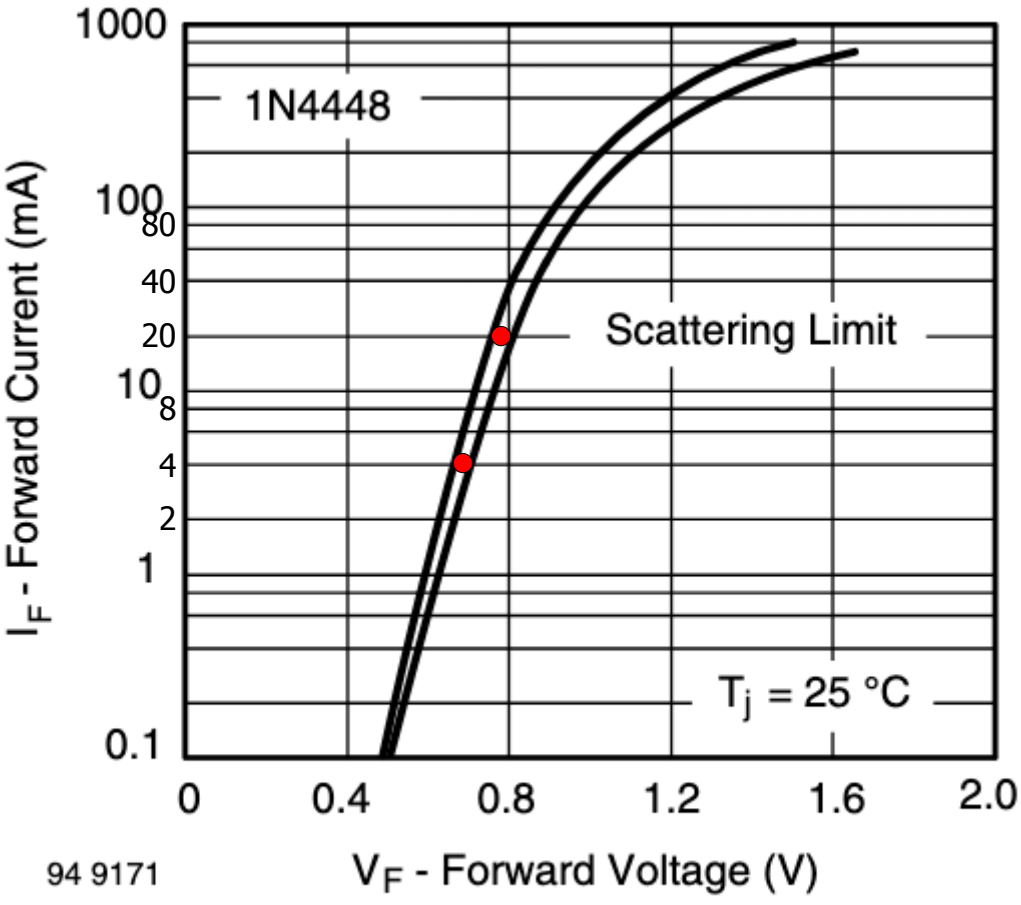

Fig. 2 - Forward Current vs. Forward Voltage

$$R = \frac{(0.8-0.7)\,\mathrm{V}}{(20-4)\,\mathrm{mA}} = 6.25\ \Omega$$

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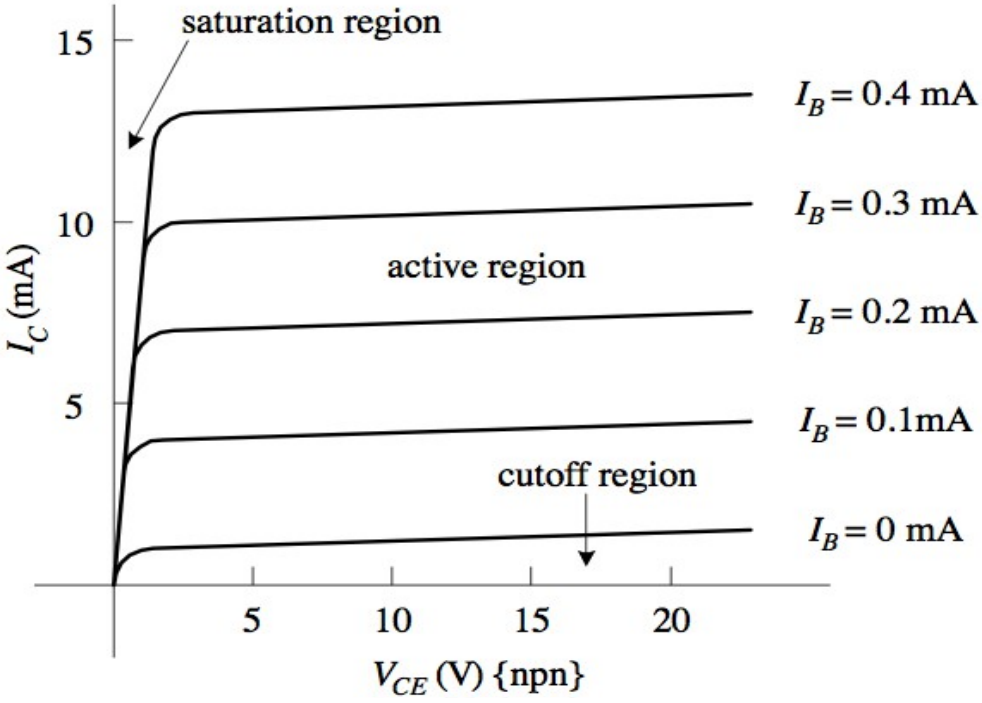
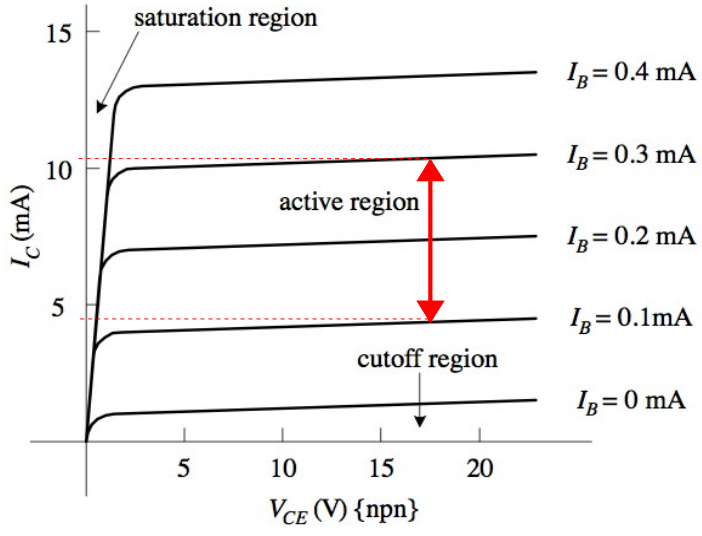
2. Compute the approximate current gain of this NPN transistor if the input base current is ±0.1 mA with an offset of 0.2 mA. Current gain $G = I_C/I_B$.





$$G = \frac{\Delta I_C}{\Delta I_B} = \frac{(10-4)e-3}{(0.3-0.1)e-3} = \frac{6\text{e-}3}{0.2\text{e-}3} = 30 \text{ (rather low for a BJT)}$$

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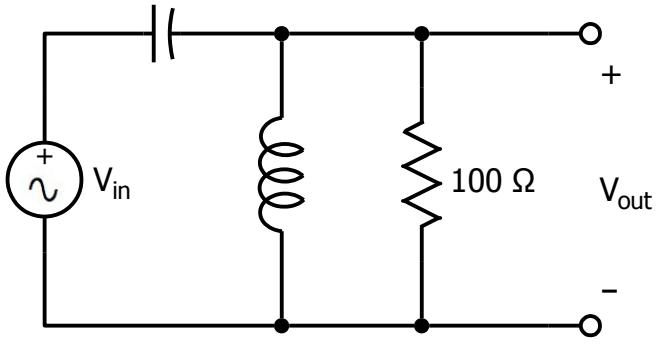
Practice Problems 7

One can make use of resonance to provide amplification at a given frequency. In this circuit, we want the gain $|V_{out}/V_{in}|$ to be 10 at 1 KHz. Find L and C.



$$\frac{V_{out}}{V_{in}} = \frac{R \| Z_L}{Z_C + R \| Z_L} = \frac{\frac{j\omega RL}{R + j\omega L}}{\frac{1}{j\omega C} + \frac{j\omega RL}{R + j\omega L}} = \frac{j\omega L}{j\omega L + \frac{j\omega L + R}{j\omega RC}} = \frac{j\omega L}{j\left(\omega L - \frac{1}{\omega C}\right) + \frac{L}{RC}}$$

Gain is max at resonance when $\omega L = \frac{1}{\omega C}$

$$\left|\frac{V_{out}}{V_{in}}\right| = 10 = |j\omega RC| = 2\pi(100)\cdot(1000)C \rightarrow C = 15.9\ \mu\text{F}$$

$$L = \frac{1}{\omega^2 C} = 1.59\ \text{mH}$$