1. **Following the derivations leading to Eq. (12.16) as shown below, prove that the other 50% of supply power is dissipated by the transistor itself.**

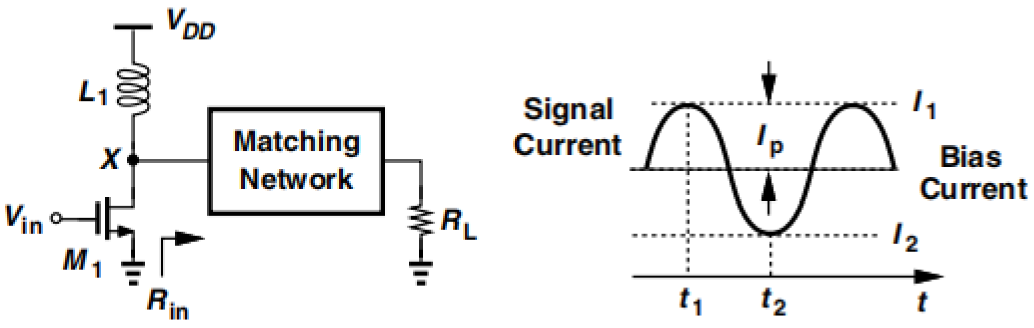

Figure 12.11 *Class A stage.*

Let us now compute the maximum drain (collector) efficiency of class A amplifiers. To reach maximum efficiency, we allow V_X in Fig. 12.11 to reach $2V_{DD}$ and nearly zero. Thus, the power delivered to the matching network is approximately equal to $(2V_{DD}/2)^2/(2R_{in}) = V_{DD}^2/(2R_{in})$, which is also delivered to R_L if the matching network is lossless. Also, recall from Example 12.1 that the inductive load carries a constant current of V_{DD}/R_{in} from the supply voltage. Thus,

$$\eta = \frac{V_{DD}^2/(2R_{in})}{V_{DD}^2/R_{in}} \tag{12.15}$$

$$= 50\%. \tag{12.16}$$

Assume a current bias of M1 equals to $\frac{V_{DD}}{R_{in}}$

Only on this condition, $\eta = 50\%$

$$V_x(t) = V_{DD}(1 + cos\omega t)$$

$$I_d(t) = \frac{V_{DD}}{R_{in}}(1 + cos\omega t)$$

$$P_{M1} = \frac{1}{2T}\int_0^T V_x(t)I_d(t)dt = \frac{1}{2T}\int_0^T \frac{V_{DD}^2}{R_{in}}(1 + 2cos\omega t + \cos^2 \omega t)dt = \frac{3V_{DD}^2}{4R_{in}}$$

2. Why do power amplifiers need high linearity, and how to measure the nonlinearity of power amplifiers?

a) PA nonlinearity leads to: 1) high adjacent channel power as a result of spectral regrowth, and 2) amplitude compression which would cause information damage especially in ASK modulation.

b) 1-dB compression point.