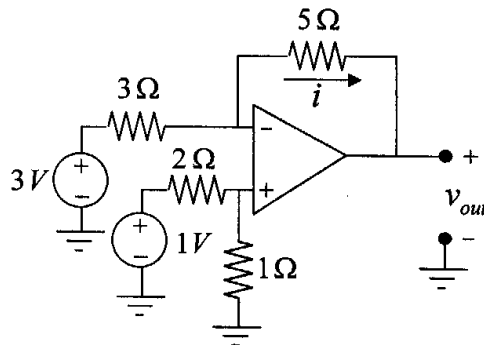
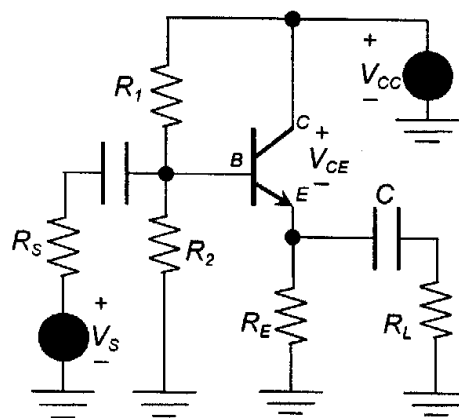


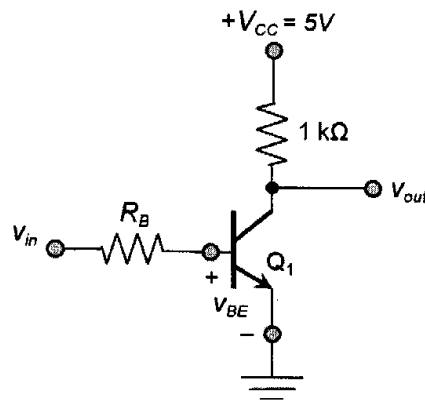
1. (30%) Consider the circuit with an ideal operational amplifier, as shown below.
 - 1.a (10%) Please describe the properties of an ideal operational amplifier.
 - 1.b (10%) Please find the current i flowing through the resistor 5Ω .
 - 1.c (10%) Please find the output voltage v_{out} .



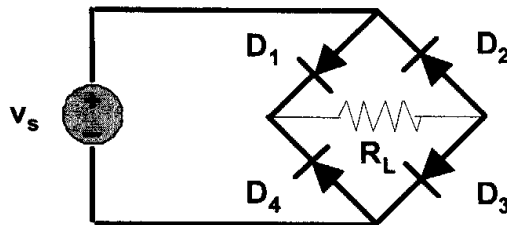
2. (20%) The circuit shown below is a common-collector (also called an emitter follower) amplifier stage implemented with an *npn* silicon transistor. Determine V_{CE} at the DC operating or Q point. (Use $V_\gamma = 0.7V$ and $V_{CE@Saturation} = 0.2V$, if necessary). Assume $V_{CC} = 12V$; $\beta = 120$; $R_1 = 82k\Omega$; $R_2 = 22k\Omega$; $R_S = 1k\Omega$; $R_E = 0.5k\Omega$; $R_L = 16\Omega$; $v_s = 1\cos(6.28 \times 10^3 t)$ mV.



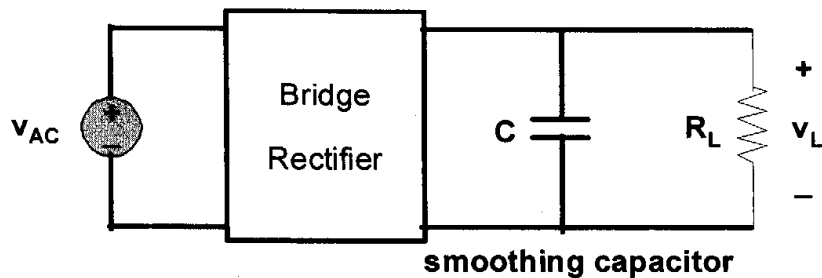
3. (10%) Consider the circuit shown below. The minimum value of v_{in} for a high input is 2 V. Assume that transistor Q_1 has a β of at least 10. Find the range for resistor R_B that can guarantee that the transistor Q_1 is on (i.e., in active linear region). (Use $V_\gamma = 0.7V$ and $V_{CE@Saturation} = 0.2V$, if necessary)



4. (20%) About DC power supply
- 4.a (5%) Consider the following bridge rectifier. Discuss the operation modes of D_1 , D_2 , D_3 , and D_4 when $v_s > 0$.

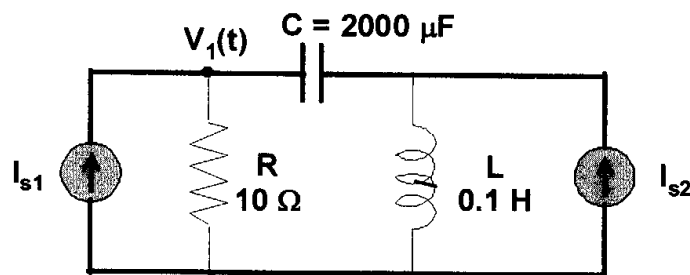


- 4.b (5%) Consider the following DC power supply. Draw the correct connection of the bridge rectifier with the smoothing capacitor C and load resistor R_L .



- 4.c (10%) Consider the DC power supply shown above again. Let $v_{AC}(t) = v_0 \sin \omega t$. As time goes to infinity, analyze (i) the output voltage v_L across R_L and (ii) the operation modes of the four diodes D_1 to D_4 of the bridge rectifier.

5. (10%) Consider the following RLC circuit with two sinusoidal current sources. Use the **Node Voltage Analysis Method** to find the steady state sinusoidal response at $V_1(t)$, the voltage across the resistor. Assume $I_{s1}(t) = 2 \sin(100t)$, $I_{s2}(t) = 1.5 \cos(100t)$ and $R = 10 \Omega$, $C = 2000 \mu\text{F}$, $L = 0.1 \text{H}$



6. (10%) Consider the following CMOS logic circuit. Let $V_1 = V_{ss}$ and $V_2 = 0 \text{V}$. Discuss
- the operation mode of every MOSFETs, M_1 to M_4 and
 - determine V_{out} .

