EE101: Electrical Sciences

Long-Assignment-2, Due date: Nov. 15, 2017

Analog Electronics

Question-1: The symbol of an npn-BJT (Bipolar Junction Transistor) is shown in Fig. 1(a). It has three terminals base (B), collector (C), and emitter (E). The DC characteristics of the BJT are given by

$$I_C = I_E = \beta I_B = I_S e^{\frac{V_{BE}}{\eta V_T}},$$

where I_S, η, β, and V_T are all constants.

Fig. 1(b) shows an amplifier using the npn-BJT. In this amplifier, the coupling capacitors C_c are very large. For a DC analysis assume the coupling capacitors are open circuited and for a small-signal analysis assume the coupling capacitors act as short circuits. In Fig. 1(b), $V_{dd} = 15\ V$, $R_1 = 100\ k\Omega$, $R_2 = 50\ k\Omega$, $R_L = 5\ k\Omega$, $\beta = 100$, and $R_E = 3\ k\Omega$.

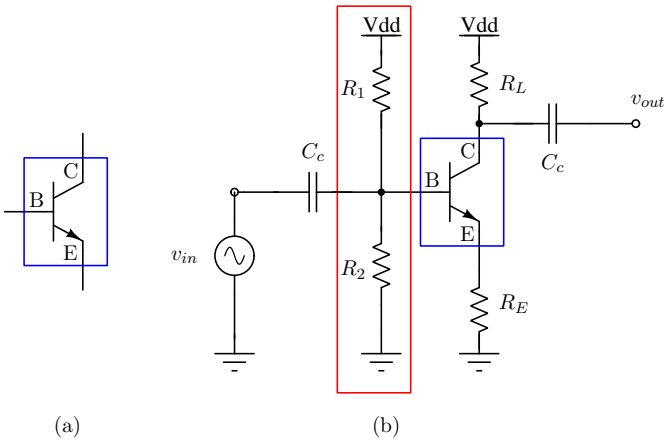

Figure 1: (a) The symbol of an npn-BJT, and (b) an amplifier using the BJT.

(i) Write the equations involving I_E and V_{BE}. (Do not try to solve this equations at this step).

(ii) All silicon based npn-BJTs maintain $V_{BE} = 0.7\ V$ while conducting (reasons will be discussed in the class). Assuming $V_{BE} = 0.7\ V$, solve the above equations to find V_E and I_E.

(iii) What is the base voltage V_B? Remember: $I_E = \beta I_B$ and some current can flow into the base terminal of the BJT.

(iv) What is the collector voltage V_C?

(v) What is the purpose of the resistive divider (R_1 and R_2) and the coupling capacitors?

(vi) What is the voltage gain of this circuit? Remember: for small-signal analysis $v_{be} \neq 0.7$ V.

Polyphase Circuits/Magnetic Circuits

Question-2: Let **Is = 2 cos (10t) A** in the circuit shown in Figure 2. Find the total energy stored at t = 0 if,
(i) a-b is open circuited,
(ii) a-b is short circuited.

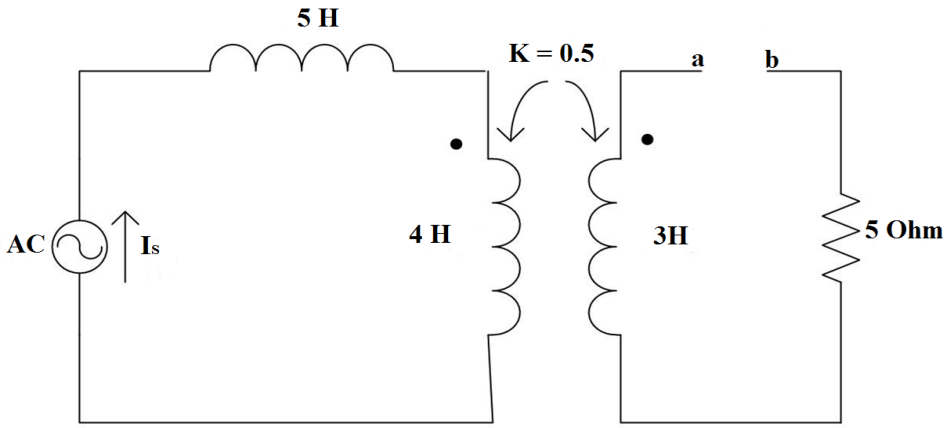

Figure 2

Question-3: An electromagnet of square cross section, shown in Figure 3, has a coil of 1500 turns. The inner and outer radii of the core are 10 cm and 12 cm respectively and the air gap is 1 cm. If the current in the coil is 4 A and the relative permeability of the core material is 1200, determine the flux density in the circuit (Core thickness is 2 cm).

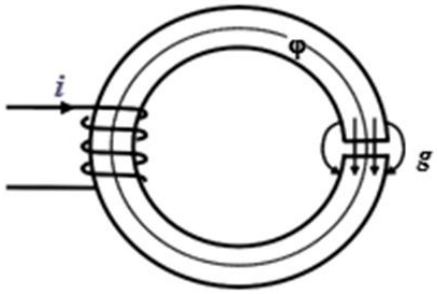

Figure 3: Magnetic circuit with airgap

Question-4: A three-phase, 400 V source supplies a load with an equivalent star impedance of 60+j15 Ω per phase through a transmission line of impedance 0.3+j1.0 Ω per phase. Compute:

(i) the line current,

(ii) the load voltage,

(iii) the power, the reactive power and the VA consumed by the load,

(iv) the power and the reactive power loss in the line and

(v) the power, the reactive power and the VA supplied by the source.