Exam-02 – BJTs and BJT circuits

1. This question concerns Class-D amplifiers.
   (a) Consider a Class-D amplifier that serves as an audio amplifier. Assume that the input of the Class-D amplifier is a sine wave (originating from an audio signal). Sketch the audio input signal into the audio amplifier. Then sketch the associated output signal of the Class-D amplifier (the output signal is received by a loudspeaker).
   (b) Assume that a Class-D amplifier is used to drive the electric motor of an electric car. Sketch the output signal of the Class-D amplifier (received by the motor) when the electrical power is 10% of its maximum. Then sketch the output signal for 90% of its maximum.
   (c) What is a marked advantage of the Class-D amplifier? Explain your answer.

2. Consider a two-stage transistor amplifier with the 1st stage being a common-emitter npn BJT circuit, and the 2nd stage being a common-collector npn BJT circuit. The two stages are separated by a DC blocking capacitor. Each stage has a base voltage divider circuit consisting of two resistors (R_{B1} and R_{B2} for the 1st stage, and R_{B3} and R_{B4} for the 2nd stage). The BJTs have a □ = 100. The power supply voltage V_{CC} = 10 V DC.
   (a) Sketch the circuit diagram.
   (b) Sketch the small-signal AC equivalent circuit diagram.
   (c) Calculate the output impedance of the 2nd stage.
   (d) Choose the circuit components of the 2nd stage to yield an output impedance of 100 Ω and choose the emitter current of the transistor so that the DC operating point is in the middle of the load line. Give the value of voltage V_{CE} (numerical value) and the emitter current (I_E) (numerical value).
   (e) Determine the base voltage (V_B) and base current (I_B) of the 2nd stage.
   (f) How should the current through the base voltage divider compare with the base current of the 2nd stage? Choose the current through the base voltage divider. Determine the associated resistances R_{B3} and R_{B4} (numerical values).
   (g) Sketch the circuit diagram of the 2nd stage of the amplifier and give all resistance values.
   (h) Sketch the small-signal equivalent circuit of the 1st stage of the transistor amplifier. Derive the voltage amplification (A_{VOC}) of the 1st stage.
   (i) Assume that the collector resistance is 200 Ω. Choose the emitter current of the transistor such that the voltage amplification ($|A_{VOC}|$) of the 1st state has a value of 20.
   (j) Determine the base voltage (V_B) and base current (I_B) of the 1st stage.
   (k) How should the current through the base voltage divider compare with the base current of the 1st stage? Choose the current through the base voltage divider. Determine the associated resistances R_{B1} and R_{B2}.

3. Are the following statements True or False? Justify your answer.
   (a) An ideal transistor amplifier has an infinite input impedance and a common-emitter BJT amplifier comes close to the ideal.
   (b) A DC blocking capacitor may also be referred to as a low-frequency pass filter.