Department of Electronic & Telecommunication Engineering

University of Moratuwa

B.Sc. Eng., Semester 2

EN1014: Electronic Engineering

Tutorial on Transistors and Basic Transistor Amplifiers

1.
  (a) Name two types of bipolar junction transistors.
  (b) Draw their circuit symbols and mark the direction of current flow in each of the terminals.
  (c) What are the names of the two modes in which a bipolar junction transistor can be operated?
  (d) If a bipolar junction transistor is to be used for amplifying small signals what should be the biasing for the two internal p-n junctions?

2.
  (a) An n-p-n transistor having a static current gain (h_{FE}) of 550 in common emitter configuration is to be operated with a quiescent base current of 40µA. Calculate it's collector and emitter currents.
  (b) The same transistor is used in common base configuration with the same quiescent base current. Calculate the static current gain (h_{FB}).
  (c) Applying Kirchoff's current law to a BJT, prove $h_{FB} = \dfrac{h_{FE}}{(1 + hFE)}$

3.
  The relationship between the collector current and base voltage of a BJT is given by,

  $$I_C = I_{SO}e^{\left[\frac{V_{BE}}{V_T}\right]}$$

  Where, I_{SO} is a scale factor directly proportional to the cross sectional area of B-E junction and V_T is 26mV at 300K, which is known as the voltage equivalent of temperature. Find the increase in the base voltage necessary to get a ten-fold increase in collector current when the transistor is operating at 300K.

4.

  A common emitter amplifier with fixed bias should be designed to operate with a 9
  V DC power supply and have quiescent collector current and voltage values of, 9.2
  mA and 4.4V respectively. The transistor has a DC current gain of 115 and a base-
  emitter voltage of 0.7V. Estimate the values of collector and base resistors.

5.

  a) Explain the need to provide biasing currents for transistor amplifier circuits
  b) Silicon NPN transistor with a static current gain of 60, is connected as a common
     emitter amplifier with a single bias resistor between the base and the supply. The
     supply is 6V and the load resistor is 1KΩ. Base bias resistor is 100KΩ.
     i)   Sketch the circuit diagram for the amplifier
     ii) Calculate the quiescent base and collector currents.
     iii) Determine the quiescent collector-emitter voltage.

6.

  a) The circuit of a common emitter transistor amplifier has the load line shown on
     the family of output characteristics in Fig. 1. Determine the value of the load
     resistor. Emitter degeneration is not applied in this amplifier.
  b) The base current varies by $\pm20\mu A$ when a voltage sine wave of $\pm20mV$ amplitude
     is applied to the input terminal. Draw on Fig. 1 the waveforms of base current
     and the resulting collector current.
  c) For the conditions defined in (b) calculate the amplifier's
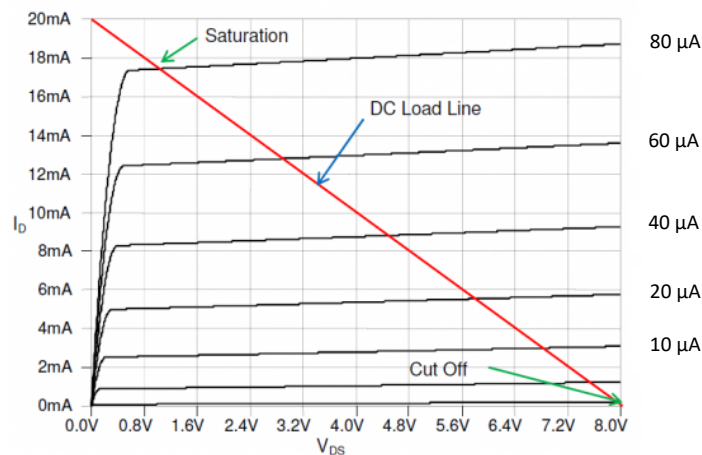   i)   Current gain
     ii) Voltage gain.

Fig. 1

7.

Refer to the circuit in Figure 2,

a) State,
    i) The mode in which it is connected
    ii) The polarity of the voltages of E and C with respect to B for normal operation.
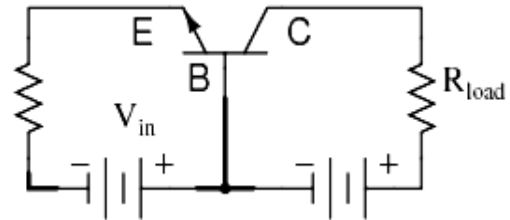

Fig. 2

b) Draw and label a typical family of output characteristic curves for this configuration

c) By referring to the curves in b) explain the meaning of the static current gain.

8.

a) Describe with the aid of a labeled diagram the construction of an p-channel Junction Gate Field Effect Transistor

b) By referring to the diagram in (a) explain how gate voltage controls the conduction in the channel.

c) The JFET has a pinch-off voltage of 4V, and saturation drain current of 6 mA. Estimate it's drain current for a gate voltage of 1V.

9.

Refer to Fig. 3 which shows a JFET audio amplifier.
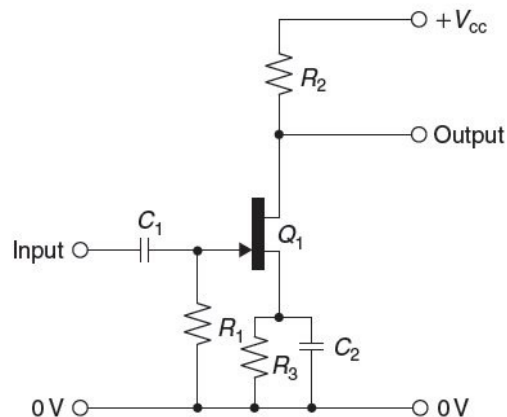Let $R_3 = 560\Omega$, $C_2 = 4.7\mu F$ and $R_1 = 180k\Omega$

Fig. 3

a) Explain the circuit functions of R_3, C_2 and R_1

b) Transistor has a saturation drain current of 8 mA and a pinch-off voltage of -4V for V_{DS} of 8 V. Calculate the channel current for a V_{DS} of 8V.

c) Calculate the supply voltage V_{DD}.

d) Sketch the DC load line on static output characteristics and mark the Q point.

e) Sketch the AC load line on static output characteristics

10.

a) Explain what is meant by 'thermal runaway' of a transistor.

b) What are the techniques you would use to prevent thermal runaway?