UNIVERSITY OF SWAZILAND
FACULTY OF SCIENCE AND ENGINEERING
DEPARTMENT OF PHYSICS

MAIN EXAMINATION, DECEMBER 2019

TITLE OF PAPER : ELECTRONICS 1

COURSE NUMBER : PHY 311

TIME ALLOWED : THREE HOURS

INSTRUCTIONS : Answer **FOUR** (4) questions only.

: Each question carries **25 Marks**

: Marks for different sections are shown in far right margin.

THIS PAPER HAS 6 PAGES, INCLUDING THIS ONE.

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1. (a) Define the following

   (i) Intrinsic semiconductor [1]

   (ii) Doping [1]

   (iii) pn-junction. [1]

   (b) Sketch a bridge rectifier and the output (without a smoothening capacitor) and explain how it works. [5]

   (c) Assume that a smoothening capacitor C was connected across the load resistor of the bridge rectifier. With the aid of a schematic diagram of the variation of the output signal with time, show that the ripple voltage, V_r can be written as [7]

$$V_r = \frac{I_{av}}{2fC},$$

   where I_{av} is the d.c. current and f is the frequency.

   (d) Modify the bridge circuit in (b) above to obtain a voltage doubler circuit and sketch the output signal if the input is sinusoidal. [4]

   (e) Consider the circuit in Figure 1 .

   (i) Using the Zener diode model, obtain the load line equation for the circuit. [4]

   (ii) Sketch the I-V characteristics of the diode together with the load line. [2]

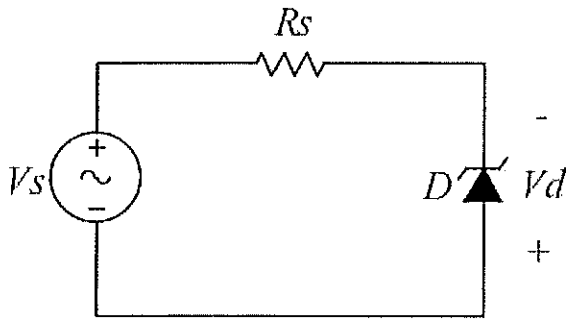

Figure 1

2. (a) Sketch and label typical drain and transfer characteristics of an n-channel JFET. [4]

(b) Write the equation for JFET transfer characteristic curve. [2]

(c) When the gate-source voltage, V_{GS} of a JFET is kept constant, a change in the drain-source voltage of 2 V leads to a corresponding change in the drain current of 0.5 mA. Use this information to calculate the drain resistance, r_d of the JFET. [5]

(d) The circuit in Fig. 2 represents a common-source amplifier. Assume $I_{DSS} = 770\ \mu A$ and $V_{GS(off)} = -3$ V.

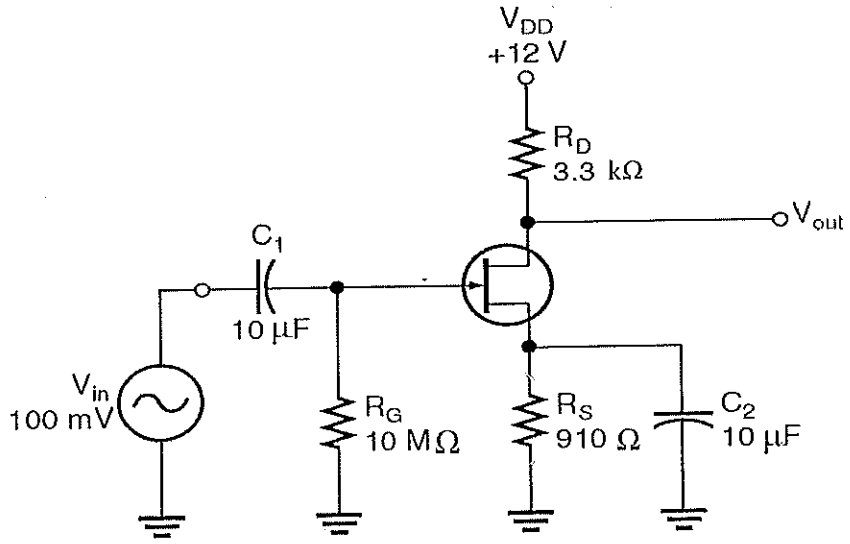

Figure 2: Common Source Amplifier

Calculate the following;

i. the drain current, I_D [5]

ii. the drain voltage V_D [2]

iii. the transconductance, g_m [4]

iv. the total output voltage of the amplifier. [3]

3. (a) With the aid of a circuit diagram, explain how a full-wave rectifier that utilises a center-tap transformer works. Sketch the output of the rectifier with reference to the transformer secondary voltage. [9]

(b) A bridge rectifier with a smoothing capacitor operates from 60 Hz. A load resistance of 1 kΩ is connected across the output terminals. The peak value of the output voltage is 24 V and the ripple voltage is 4 V.

(i) Sketch a graph of the output voltage against time with reference to the secondary voltage and label both axes. [4]

(ii) Determine the capacitance of the capacitor. [6]

(c) Fig.3 shows a half-wave rectifier with a smoothing capacitor. The average current through the load resistance is 10 mA. A period of oscillation of the secondary voltage is 20 ms and amplitude is 50 V. Calculate the average voltage across the load resistor. [6]

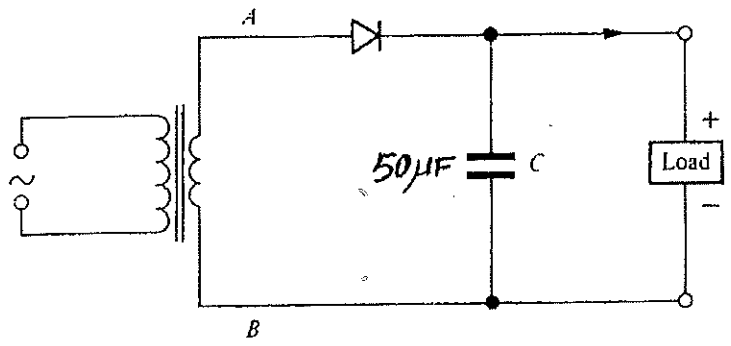

Figure 3

4. (a) Determine the Q-point for the circuit below and find the maximum peak value of base current for linear operation. Assume $\beta_{DC} = 200$. [7]

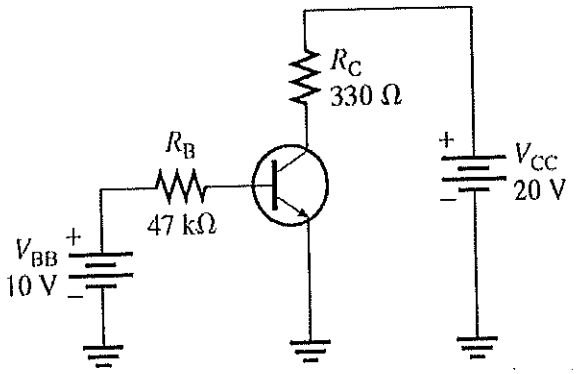

Figure 4: Bass -bias

(b) Consider the common-emitter amplifier shown in Figure 5,

(i) perform the dc analysis of the circuit. [5]

(ii) perform ac analysis of the circuit. [10]

(iii) Draw the waveforms. [3]

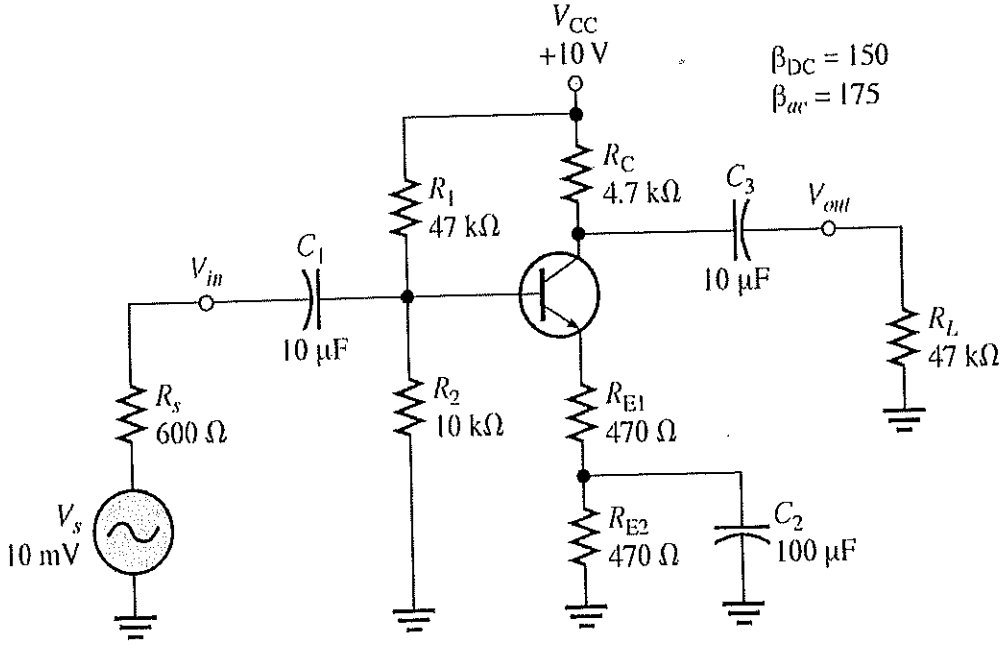

Figure 5: CE-Amplifier with R_L

5. (a) Define the hybrid parameters of the transistor in terms of the d.c. currents and voltages . [2]

(b) Describe how you would determine the hybrid parameters of a bipolar transistor from the input and output characteristics of the transistor. [6]

(c) With reference to the circuit diagram in Fig.6, calculate the values of the dc voltages V_B, V_C and V_{CE} and the direct currents I_B and I_E. Assume that the current I_{BB} flowing into the potential divider (R_1 and R_2) is much greater than I_B and $V_{BE} = 0.6$ V and $h_{FE} = 200$. [15]

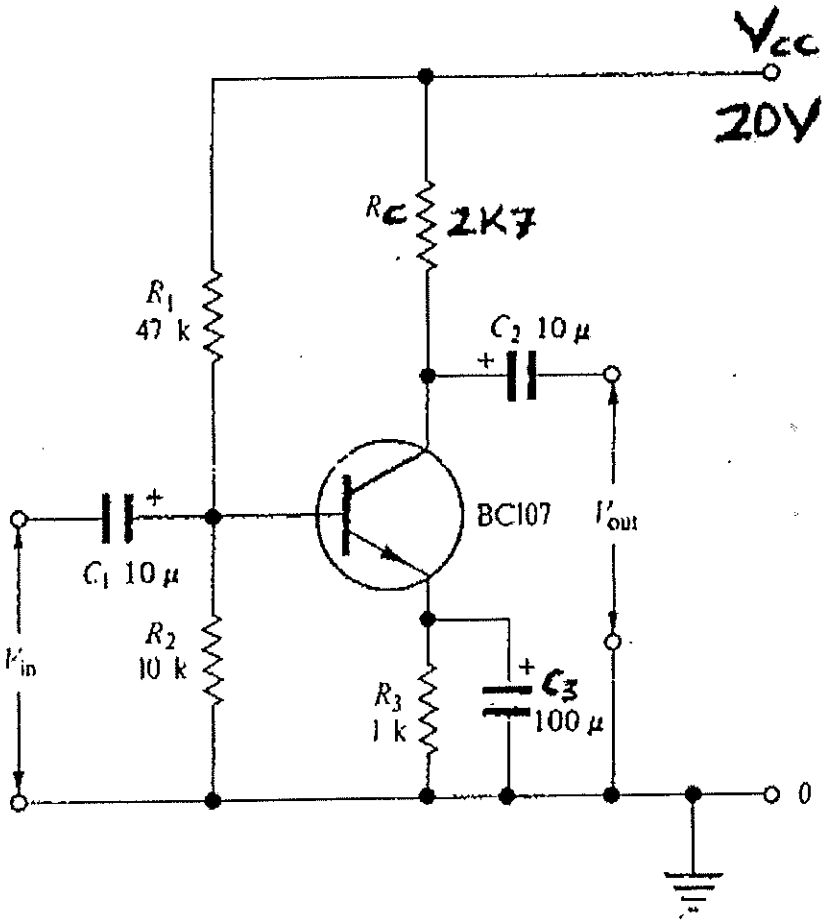

Figure 6

(d) (c) State the relation between pinch-off voltage, V_P, and cutoff voltage, $V_{GS(off)}$. [2]