UNIVERSITY OF SWAZILAND

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FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF PHYSICS

MAIN EXAMINATION	:	**2013/2014**
TITLE OF PAPER	:	**ELECTRONICS I**
COURSE NUMBER	:	**P311**
TIME ALLOWED	:	**THREE HOURS**
INSTRUCTIONS	:	**ANSWER ANY FOUR OUT OF FIVE QUESTIONS**
		EACH QUESTION CARRIES 25 MARKS
		MARKS FOR DIFFERENT SECTIONS ARE SHOWN IN THE RIGHT-HAND MARGIN.

THIS PAPER HAS 7 PAGES, INCLUDING THIS PAGE.

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QUESTION 1

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(a) Consider the common-emitter amplifier shown in Fig. 1.1.

$V_{CC} = 20$ V
$V_{BE} = 0.6$ V
$R_1 = 47$ kΩ
$R_2 = 10$ kΩ
$R_E = 1$ kΩ
$R_C = 2.7$ kΩ
$h_{FE} = 200$

Calculate values of the following d.c. voltages V_B, V_C and V_{CE} and the direct currents I_B and I_E. Consider the current, I_{BB} flowing in the potential divider network (made up of resistors R_1 and R_2) to be much greater than the base current I_B. (15 marks)

(b) An npn transistor used as a voltage amplifier in the common-emitter configuration has hybrid parameters $h_{fe} = 120$ and $h_{ie} = 1$ kΩ. Assume that the load resistance R_C is 1.2 kΩ and that the output voltage has a peak-to-peak value of 2 V. Estimate the magnitude of the input voltage.

(4 marks)

(c) The drain current in a junction field effect transistor (JFET) varies by ± 0.5 mA when the signal voltage at the input has a peak-to-peak value of 1 V. Calculate the mutual conductance of the transistor. (2 marks)

(d) Sketch typical drain and mutual characteristics of a p-channel JFET. Label them.

(4 marks)

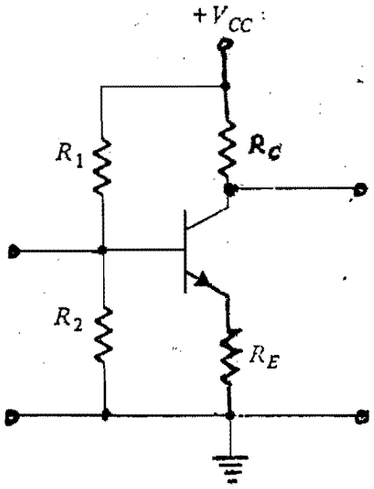

Fig. 1.1

QUESTION 3

(a) Define each of the following terms pertaining to a junction field effect transistor (JFET) and explain briefly how they can be measured with reference to appropriate sketches of graphs:

(i) mutual conductance; (4 marks)

(ii) drain conductance. (4 marks)

(b) Explain how an n-channel JFET works. Use a diagram and the I_D-V_{DS} characteristics of the transistor to illustrate your point. (8 marks)

(c) (i) Draw a small signal equivalent circuit of the common-source amplifier shown in Fig. 3.1.

(3 marks)

(ii) Derive an expression for the voltage gain of this amplifier and show that it is proportional to R_L.

(6 marks)

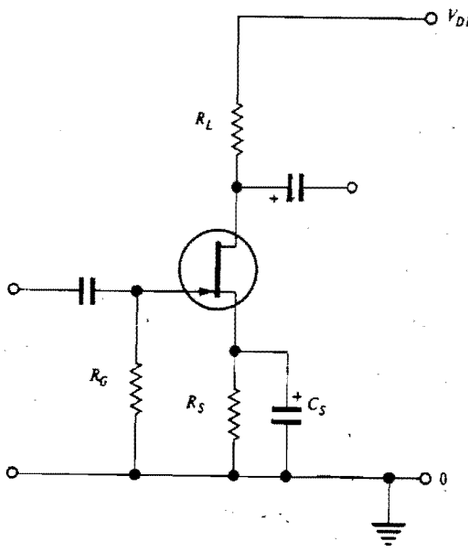

Fig. 3.1

QUESTION 4

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(a) (i) Fig. 4.1 shows the circuit diagram of a full-wave rectifier that utilises a centre-tap transformer. Explain how this rectifier works. (5 marks)

(ii) Sketch the output of the rectifier with reference to the transformer secondary voltage. Label it. (3 marks)

(b) A bridge rectifier with a smoothing capacitor operates from a 60 Hz mains supply. 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. (3 marks)

(ii) Determine the capacitance of the capacitor. (7 marks)

(c) (i) Draw the circuit diagram of a half-wave rectifier circuit with a smoothing capacitor. (2 marks)

(ii) The capacitance of the smoothing capacitor is 50 μF and the average current through the load resistor, R_L is 10 mA. Calculate the average voltage across the load resistor when the frequency of oscillation of the secondary voltage is 50 Hz and its peak value is 50 V. (5 marks)

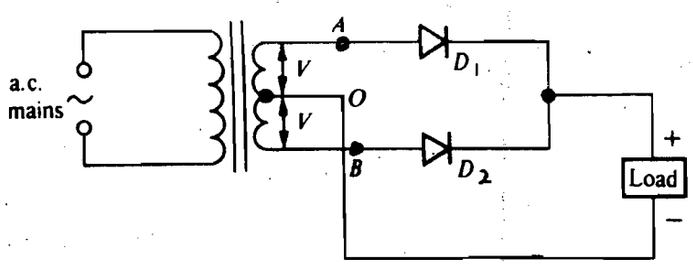

Fig. 4.1

QUESTION 5

(a) Consider a bipolar junction transistor with a current gain h_{FE} of 200. The transistor is used as an amplifier connected in the common-emitter configuration. The leakage current is 20 μA at 30 °C and increases to 480 μA at 50 °C. The steady current at the base of the transistor is 40 μA.

Calculate the percentage change in collector current when the junction temperature increases from 30 °C to 50 °C. (7 marks)

(b) An npn silicon transistor has the output characteristics shown in Fig. 5.1. The transistor is used to design a voltage amplifier. The supply voltage, V_{CC} is 10 V and the collector resistance, R_C is 330 Ω. With the aid of the enlarged graph on page 7, and the loadline concept, choose a suitable operating point and estimate the values of the parameters mentioned in (i) and (ii) below, under quiescent conditions:

(i) The collector current, I_C and collector-emitter voltage, V_{CE}; (6 marks)
(ii) The voltage drop across R_C. (2 marks)

(c) (i) Draw a small signal model of a common-emitter amplifier. Include the output resistance, $1/h_{oe}$ and the voltage generator in the model. (2 marks)

(ii) Derive the exact expressions of the current gain and voltage gain. (6 marks)

(iii) Calculate the current gain if the output conductance, h_{oe} is 20 μS. (2 marks)

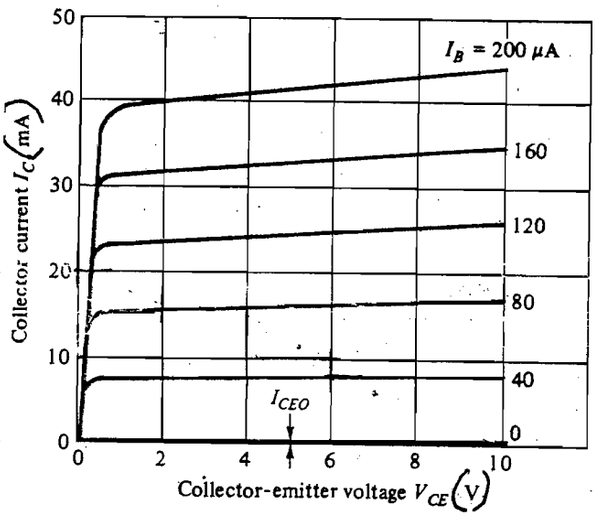

Fig.5.1

PLEASE SUBMIT THIS PAGE TOGETHER WITH YOUR ANSWER BOOK 94

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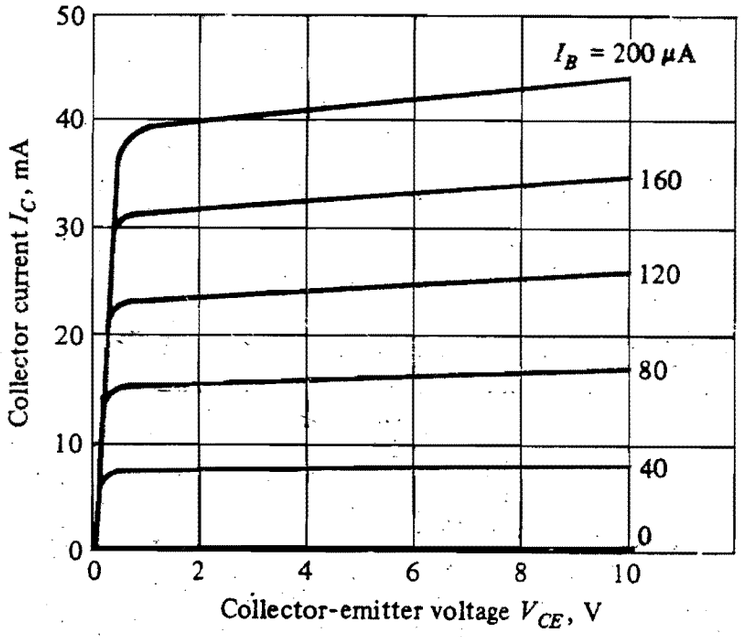

Fig. 5.1 (enlarged)