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UNIVERISTY OF SWAZILAND

P311 - ELECTRONICS I

MAIN EXAMINATION 2016
TIME ALLOWED: 3 HOURS

INSTRUCTIONS: Answer any **four (4)** questions. Each question carries 25 marks.

Question 1

(a) (i) Draw a typical I-V characteristic of a Silicon junction diode, showing the order of magnitude of the currents and voltages.(4 marks)

(ii) Are there any differences between Silicon and Germanium diodes and if yes, what are they? (2 marks)

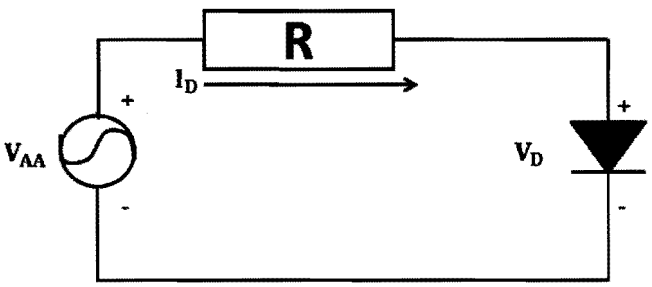

Figure 1:

(b) Figure 1 shows a simple diode circuit.

(i) Using Kirchoff's law, analyse the circuit and use your result to construct a load line to an arbitrary characteristic. (3 marks)

(ii) What does the load line depend on and what is the importance of the intersection line with the characteristics? (2 marks)

(iii) Is there only one intersection point? (2 Marks)

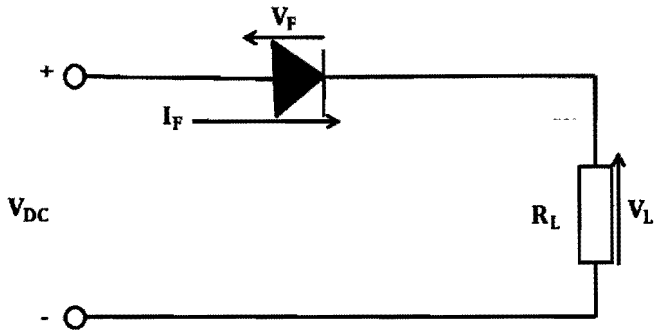

Figure 2:

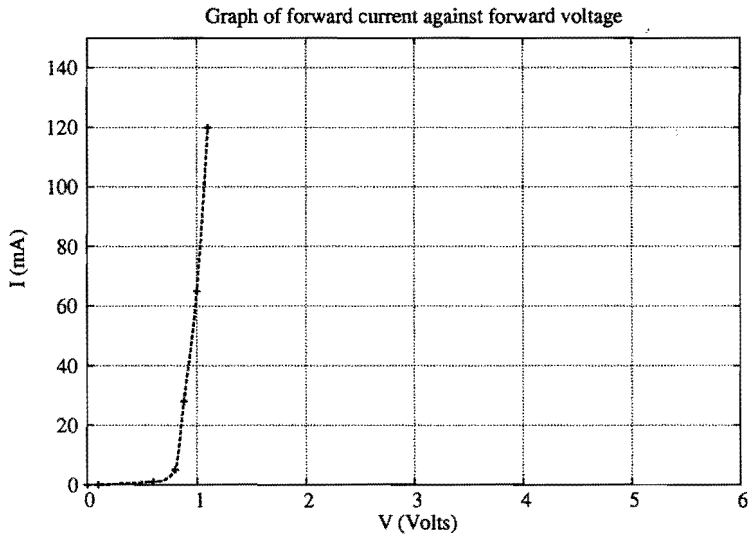

Figure 3:

(c) The diode used in circuit of figure 2 has the characteristics shown in figure 3.

(i) Use the D.C. load-line to determine the current flowing in the circuit, when the applied D.C. voltage is 5 V and the load resistance is 100 Ω. (6 marks)

(ii) Calculate the value of V_L. (2 Marks)

(iii) What value of R_L would allow a 90 mA current to flow in the circuit? (4 marks)

Question 2

(a) What property of a Zener diode makes it suitable for use as a voltage regulator? (2 marks)

(b) A D.C. power supply is a device which consist of a bridge full-wave rectifier, a smoothing capacitor and a Zener diode circuit. With aid of labelled diagrams for circuit and output waveforms, describe in detail the operation of the power supply. Indicate clearly how the 240 V r.m.s. input voltage from the main supply is converted into a D.C. voltage. (10 marks)

(c) Calculate the average output voltage of the circuit shown in figure 4 if the mains voltage is 240 V r.m.s. and the transformer turns ratio, n, is 4:1. (4 marks)

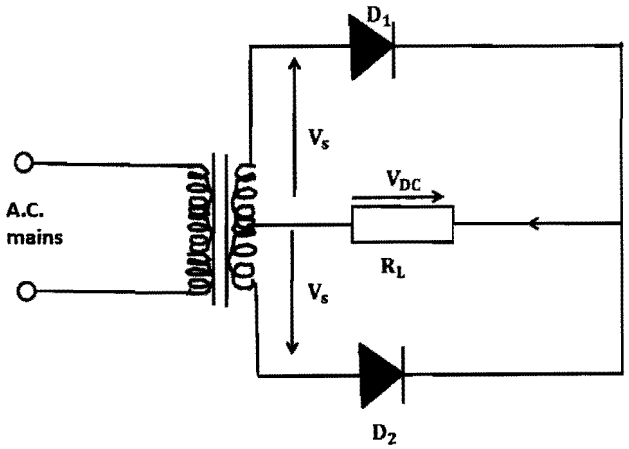

Figure 4:

(d) A Zener diode regulator circuit is to provide 24 V supply to a variable load. The input voltage is 30 V and a 24 V, 400 mW Zener diode is to be used. Calculate

(i) The series resistance required. (4 marks)

(ii) The Zener diode current when the load resistance is 2000 Ω. (5 marks)

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Question 3

The regulator circuit shown in figure 5 uses an ideal Zener diode, with $V_z = 9.1$ V, $I_{zk} = 1.0$ mA and the maximum power, $P_{z,max} = 500$ mW.

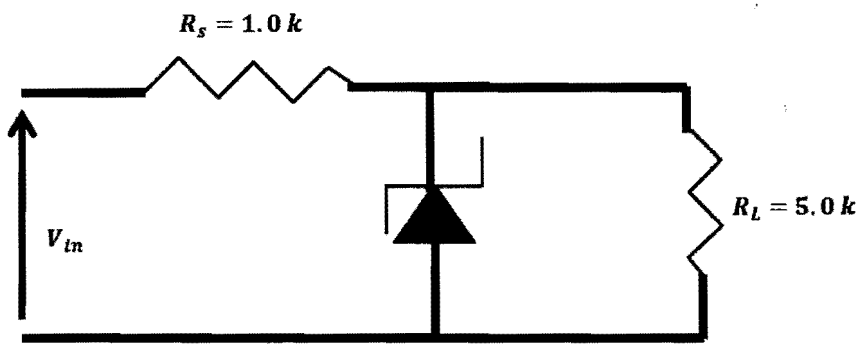

Figure 5:

(a) What are the maximum and minimum input voltages for which the output will be regulated? (9 marks)

(b) What is the power dissipation in R_L, when the output is regulated? (2 marks)

(c) What is the power dissipated in R_s at the maximum and minimum input voltages? (8 marks)

(d) What is the apparent resistance of the Zener diode at the minimum and maximum voltages? (6 marks)

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Question 4

(a) For a BJT, the relationship between the collector current, I_C and the emitter current, I_E is given by $I_C = \alpha I_E$ and that between the collector current, I_C and the base current, I_B is given by $I_C = \beta I_B$, where α and β are constants.

(i) What is the range of typical values of α ? (2 marks)

(i) Derive an expression for the relationship between α and β. (5 Marks)

(b) Assuming that $V_{BE} \approx 0.7$ V, calculate the values of I_C, V_{CE} and V_{CB} for the circuit shown in figure 6. (6 marks)

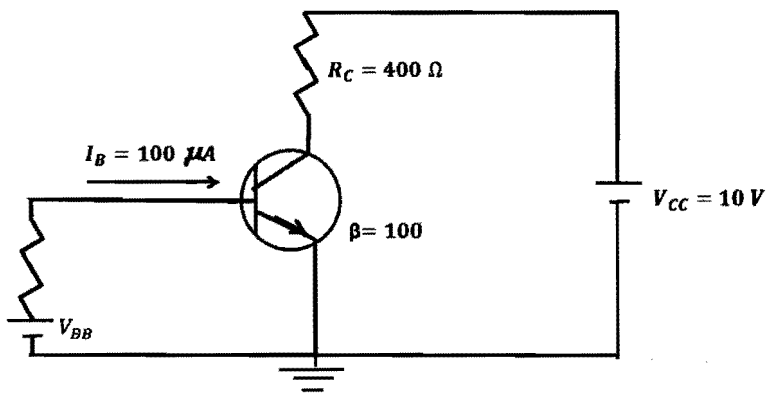

Figure 6:

(c) The element values of the circuit shown in figure 7 are: $R_1 = 150$ kΩ, $R_2 = 37.5$ kΩ, $R_E = 3$ kΩ, $R_C = 7$ kΩ, V_{CC} =9 V. The transistor has $\beta = 100$ and a negligible reverse saturation current. Assuming that $V_{BE} = 0.7$ V, Calculate I_C and V_{CE}. (12 marks)

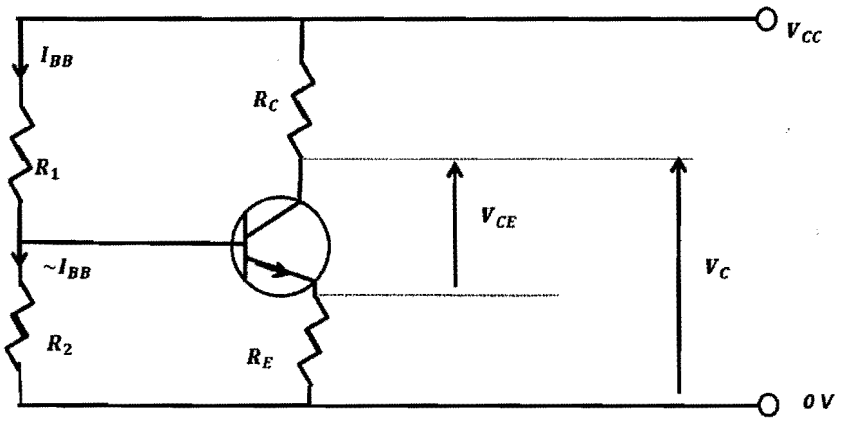

Figure 7:

Question 5

(a) Figure 8 shows the transfer characteristic curve of a JFET. Write the equation for drain current. (3 marks)

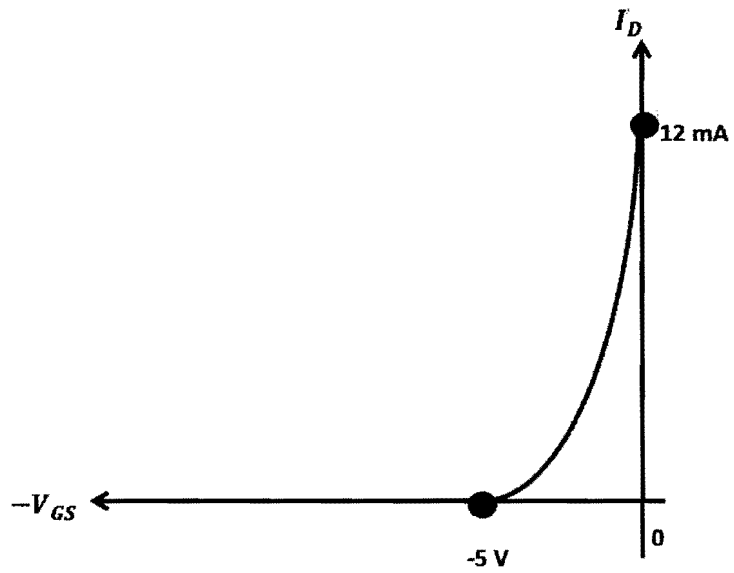

Figure 8:

(b) A JFET has the following parameters: $I_{DSS} = 32$ mA ; $V_{GS(off)} = -8$ V ; $V_{GS} = -4.5$ V. Find the value of drain current. (4 marks)

(c) A JFET has a drain current of 5 mA. If $I_{DSS} = 10$ mA and $V_{GS(off)} = -6$ V, find the value of

(i) V_{GS} (3 marks)

(ii) V_P (2 marks)

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(c) For the JFET in figure 9, $V_{GS(off)} = -4$ V and $I_{DSS} = 12$ mA. Determine the minimum value of V_{DD} required to put the device in the constant-current region of operation.(8 marks)

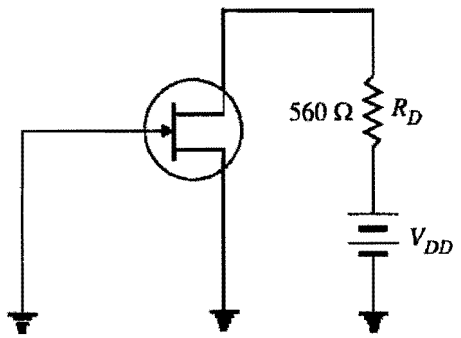

Figure 9:

(d) Determine the value of drain current for the circuit shown in figure 10. (5 marks)

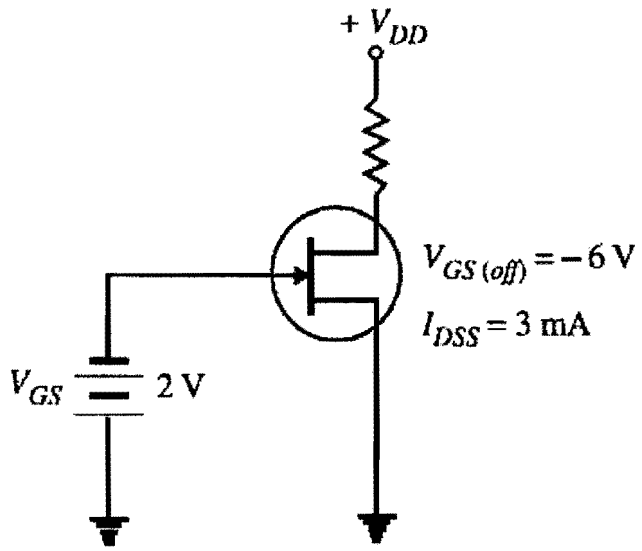

Figure 10: